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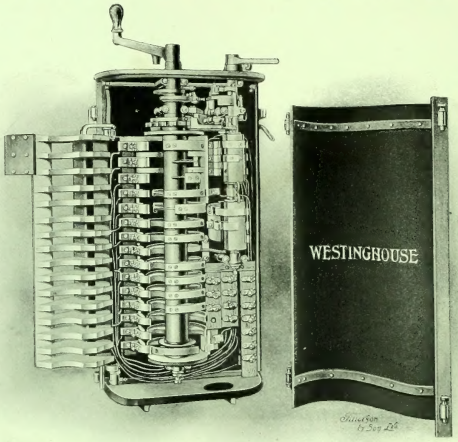
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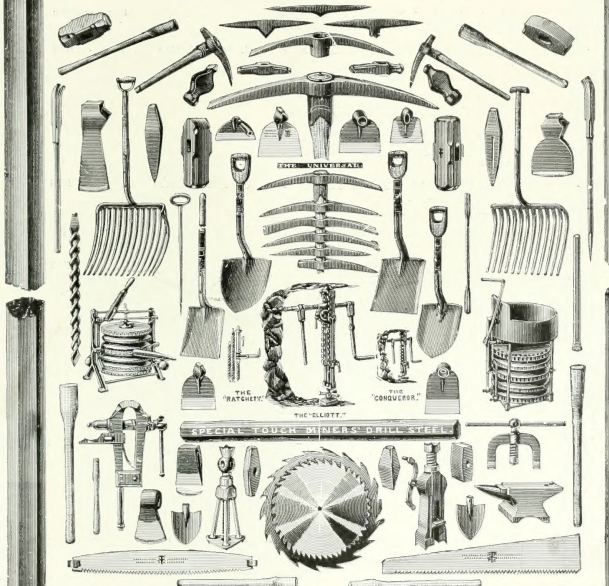
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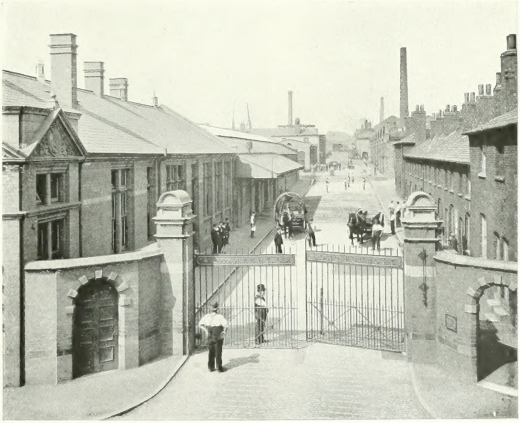
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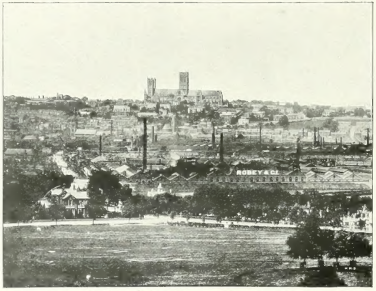
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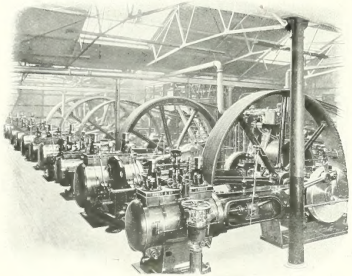


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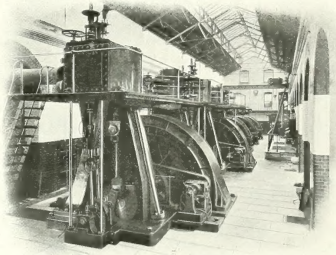
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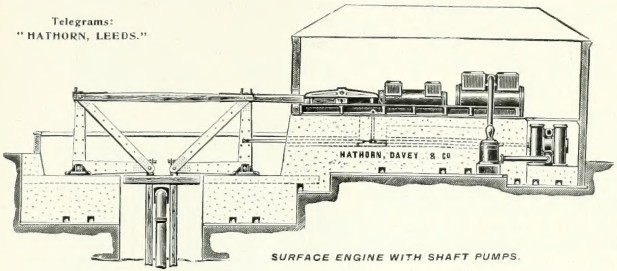
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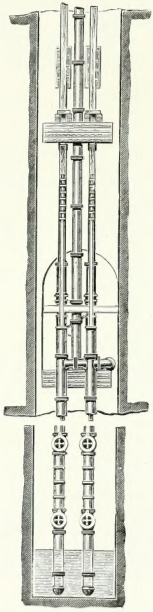
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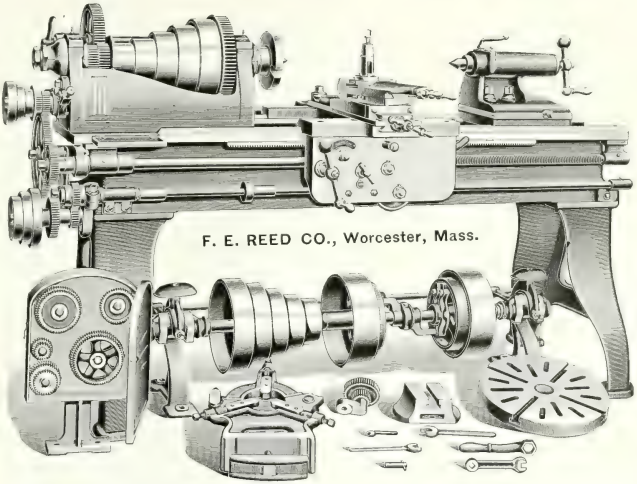
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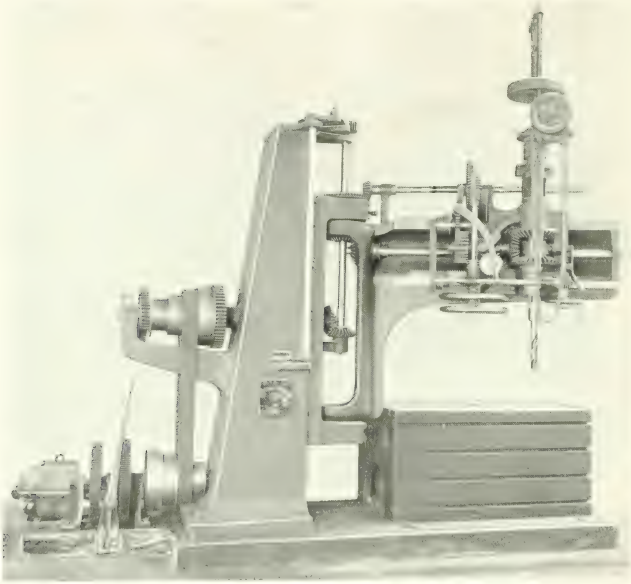
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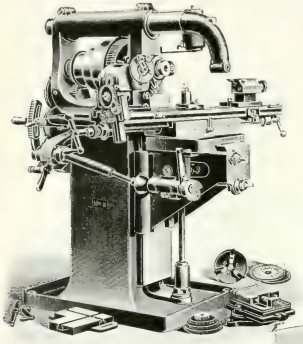
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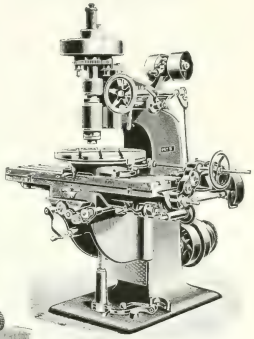
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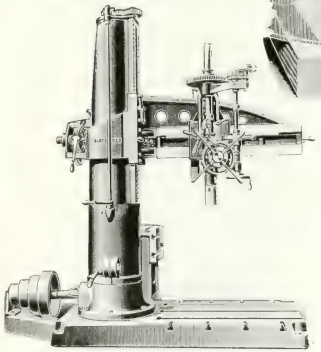
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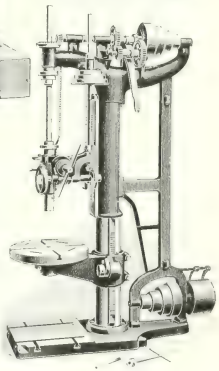


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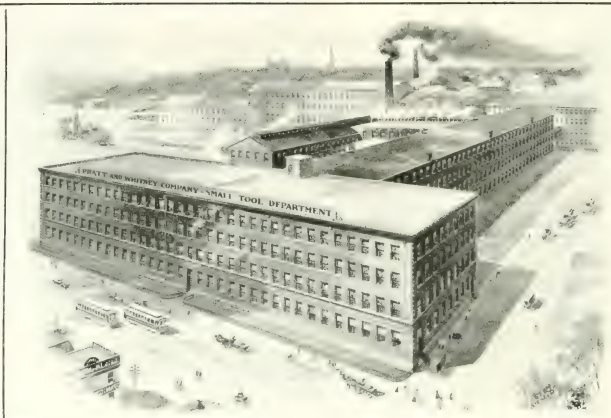
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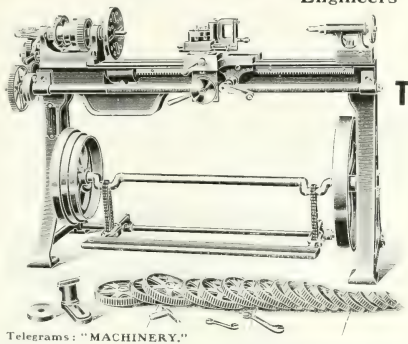
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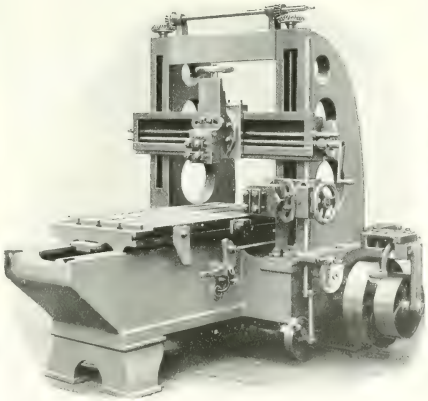
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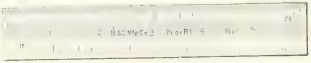
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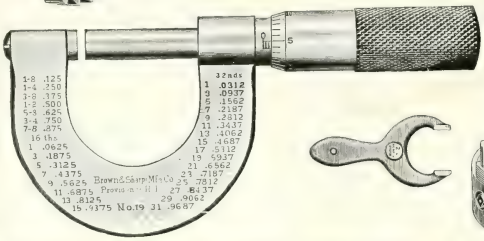


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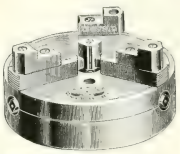
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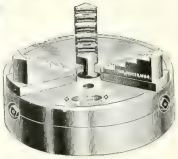


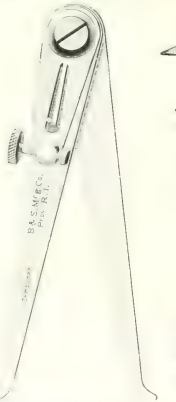
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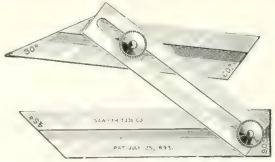


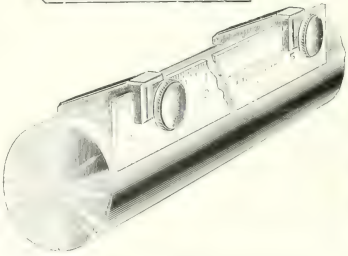


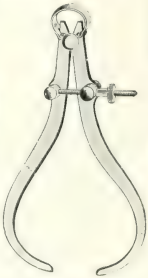








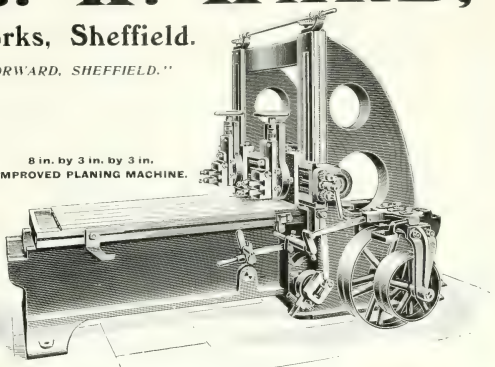




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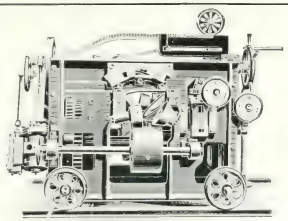


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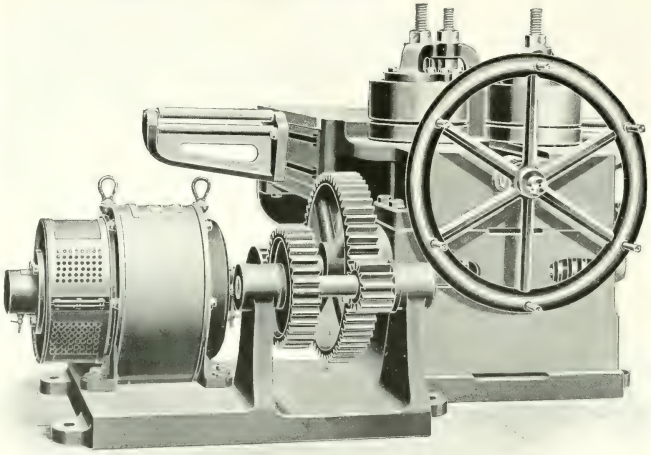
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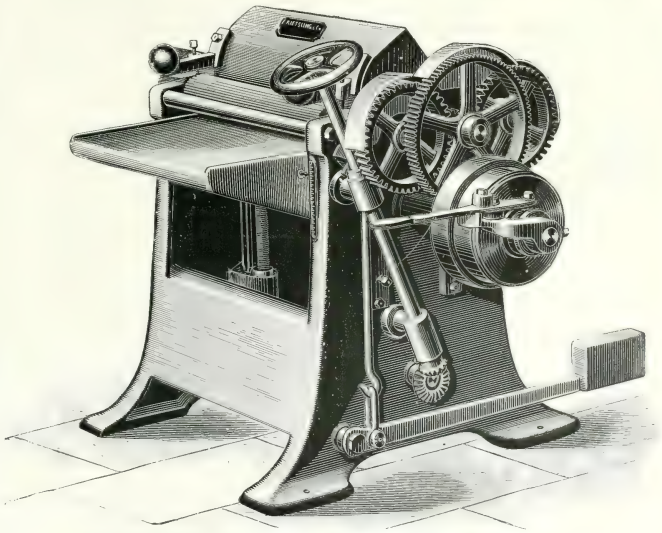
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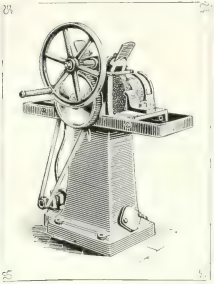
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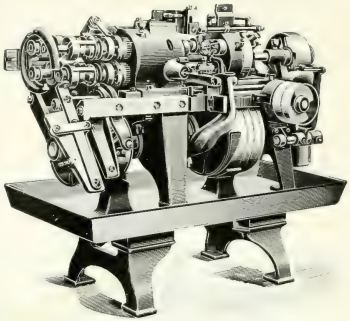
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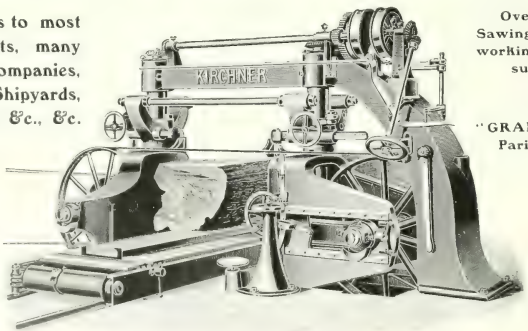
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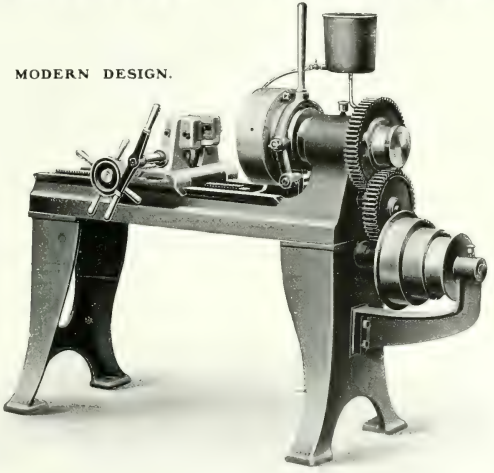
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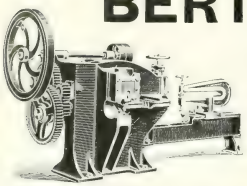
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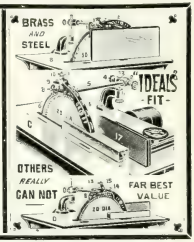
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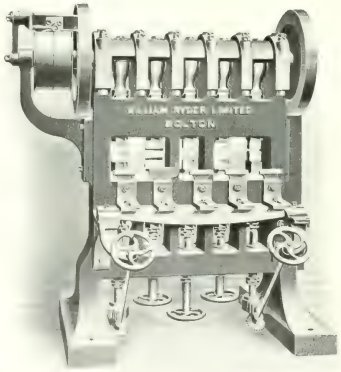
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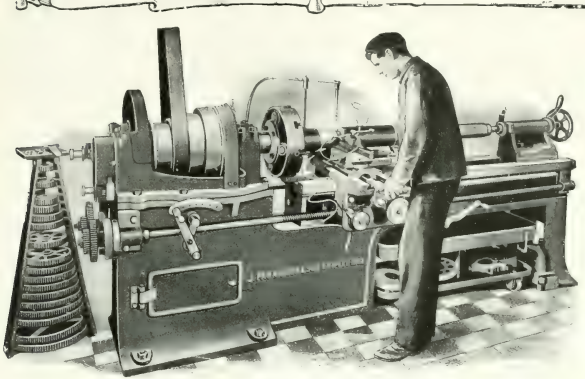
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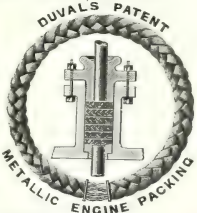
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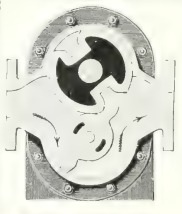
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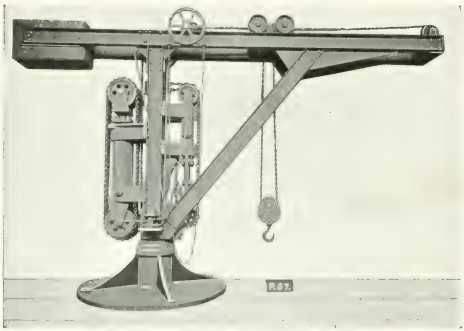
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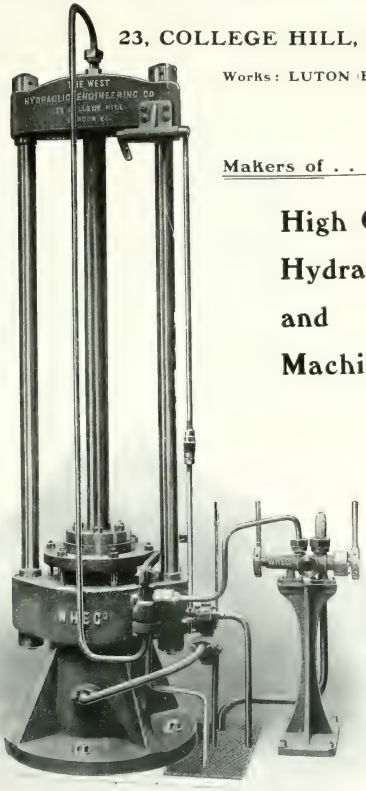
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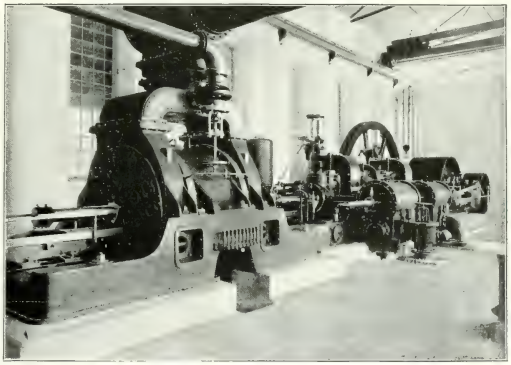
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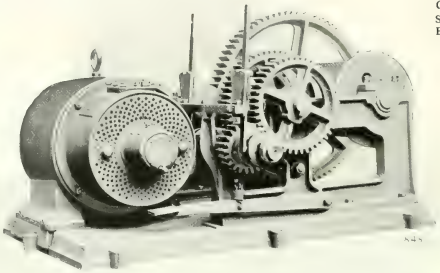
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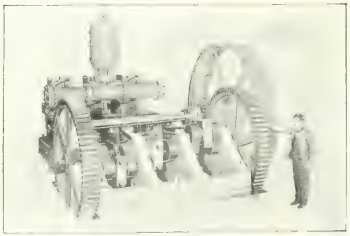
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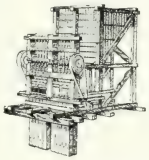
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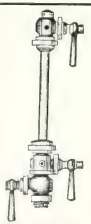


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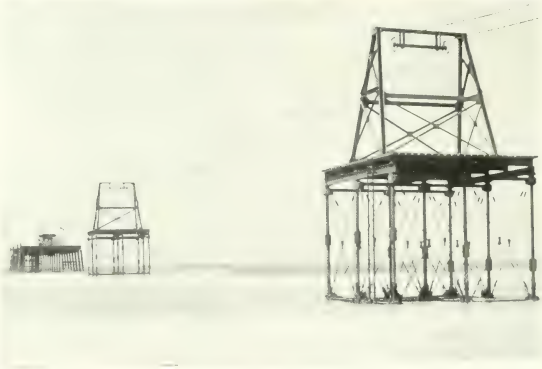
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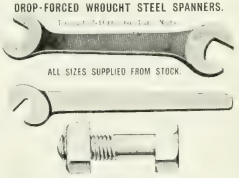
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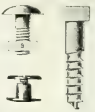




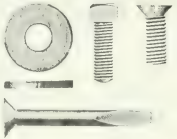
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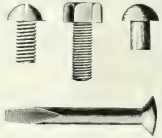
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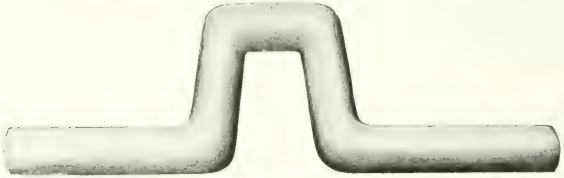
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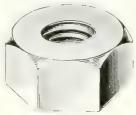
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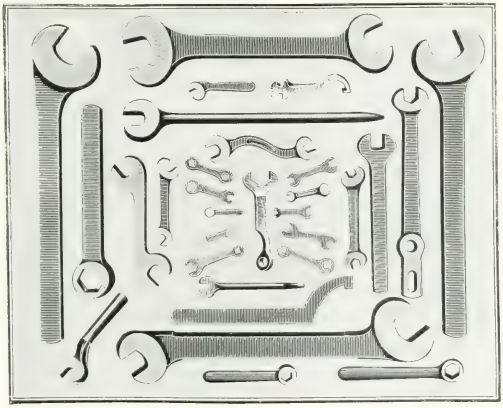


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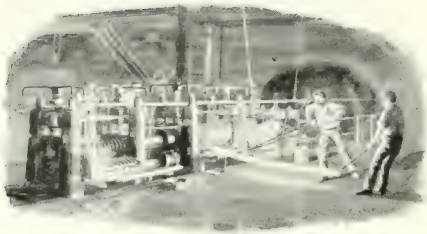
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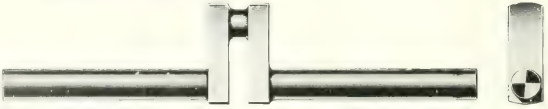
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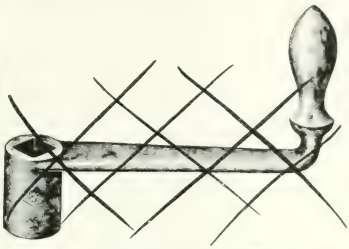
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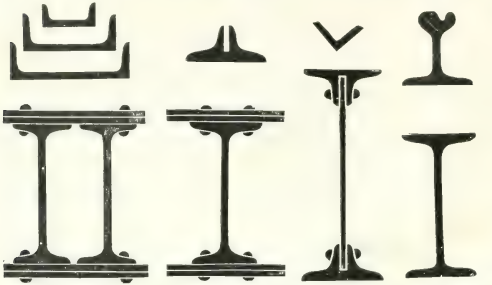


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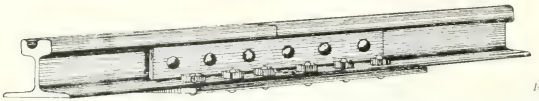
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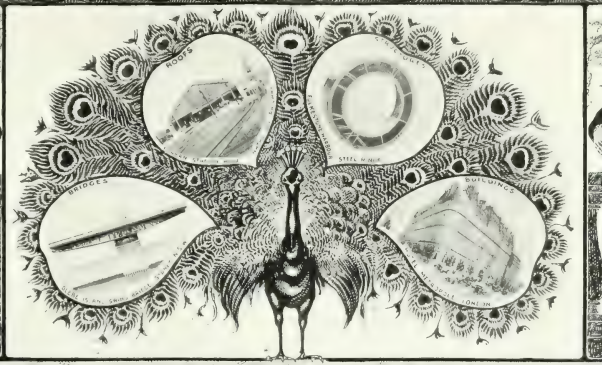
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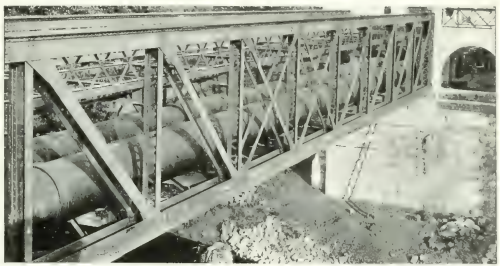
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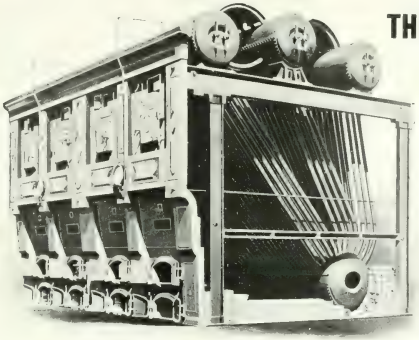
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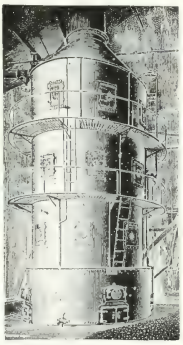
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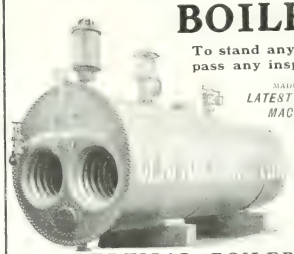
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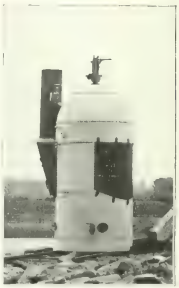
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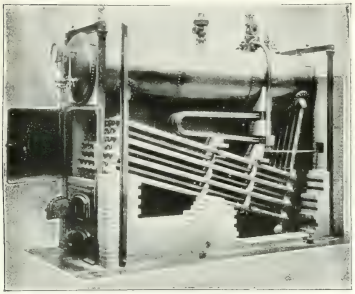
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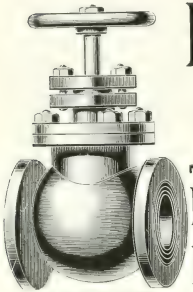
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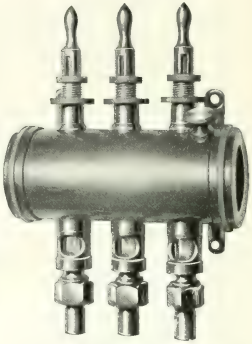
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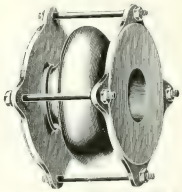


Patent "End Sight" Oil Distributing Box.
No. 881.

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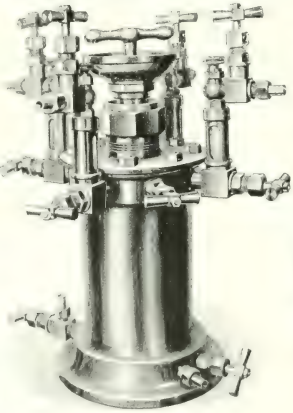


Patent Brass Copper Expansion Box for
Take-up Expansion of Pipes.

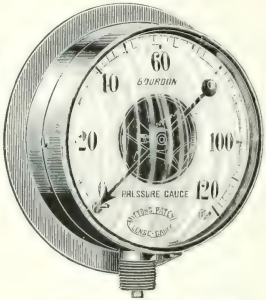


Mitton's Patent [illegible]
[illegible] Pet. Glass
No. [illegible]





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No. 803.



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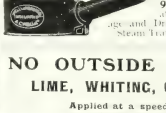


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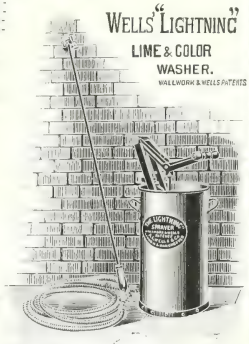
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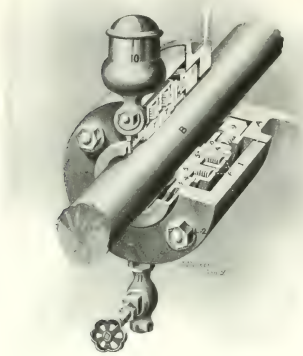
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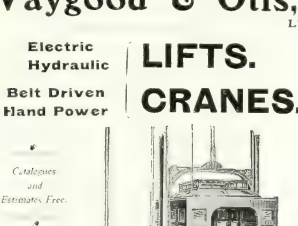


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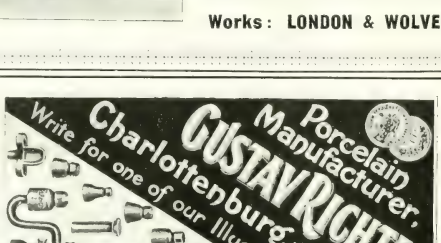
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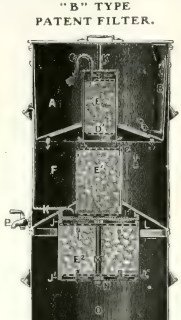
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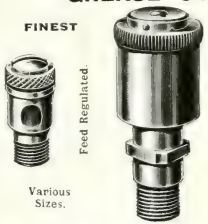
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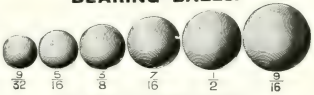
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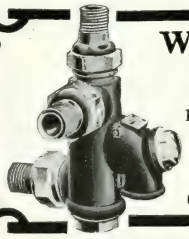
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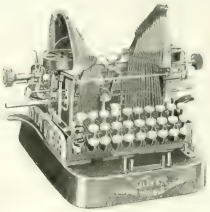
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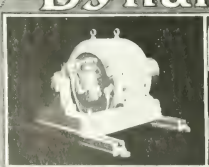
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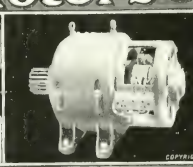
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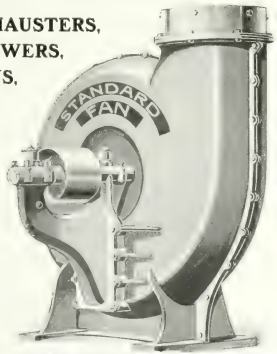
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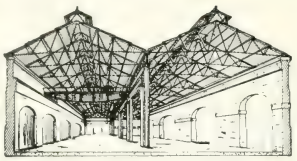
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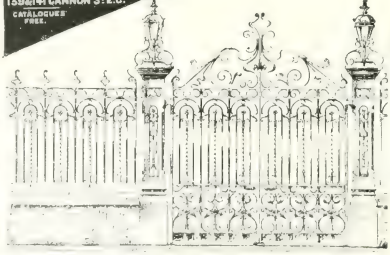
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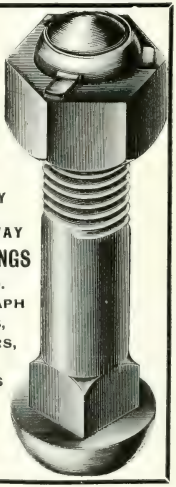
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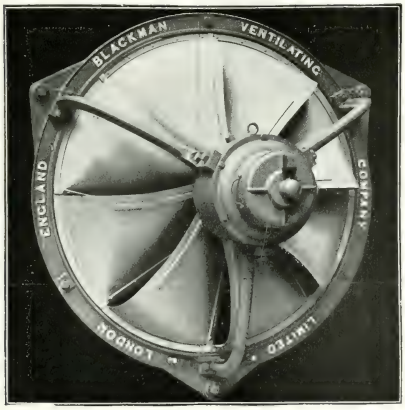
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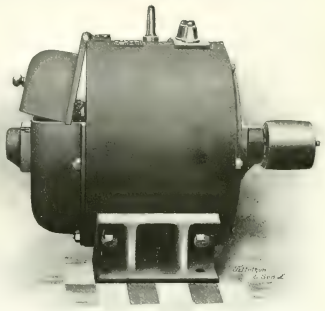
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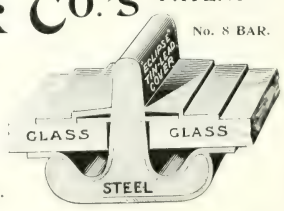
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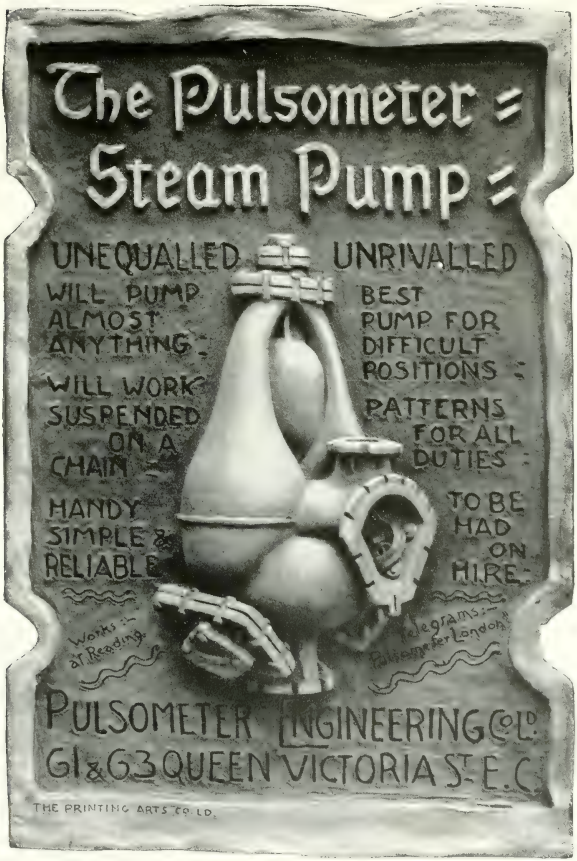
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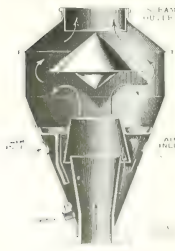
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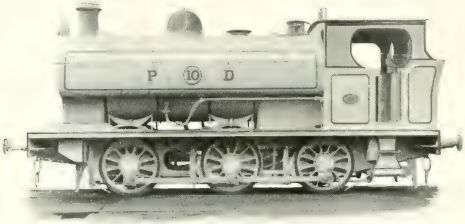
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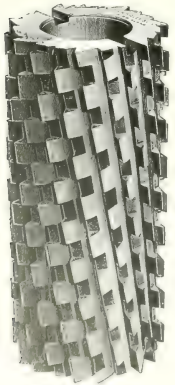
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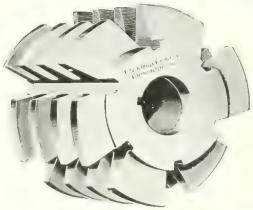
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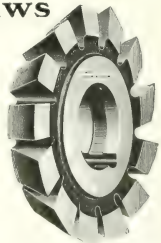
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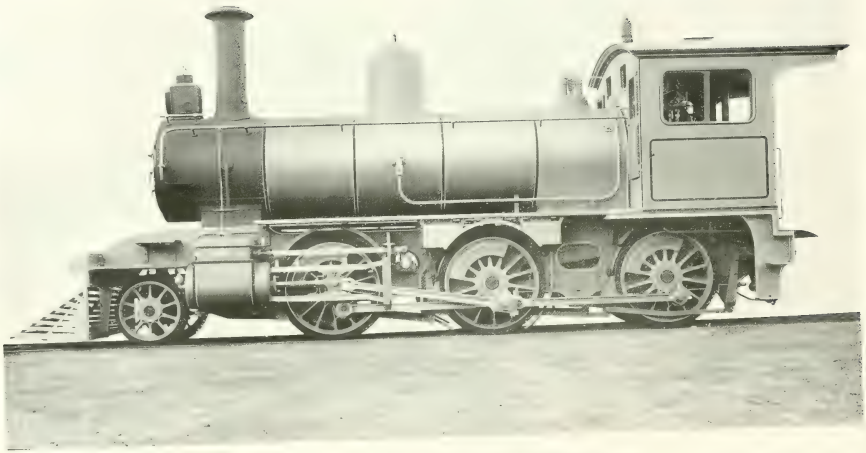
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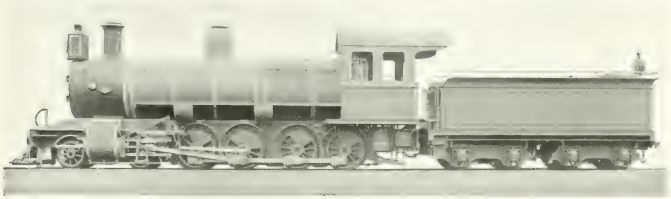


FIG. 1. TWELVE-WHEEL GOODS ENGINE BUILT FOR THE GOVERNMENT RAILWAY OF WESTERN AUSTRALIA.

BRITISH LOCOMOTIVES FOR ABROAD.

BY

CHARLES ROUS-MARTEN.

Mr. Rous-Marten's careful summary of the facts should do much to counteract the pessimistic statements which have lately been made in various quarters on the subject of the British Locomotive Industry. The author includes some most notable examples of British engines recently constructed for the export trade, and the subject will be continued.—ED.

I.

PESSIMISTIC writers upon British industries have dwelt much of late on the alleged supersession of Britain by other countries in the production of locomotives for the colonies. Stress is laid upon the fact that even Britain herself—the motherland of railways—was obliged three years ago to import from America a considerable number of goods locomotives. Still more pointed attention has been directed to the success with which various European and American manufacturers have wrested from Britain the privilege of supplying locomotives to certain British dependencies. The conclusion sought to be deduced is, that British methods are hopelessly effete, and that the star of British ascendency in this important branch of industry has set for ever.

THE TRUTH ABOUT AMERICAN COMPETITION.

I may say at once, and without the slightest hesitation, that I decline to endorse this view. Indeed, I hold very strongly a wholly opposite view. That our British manufacturers as a whole may have fallen temporarily a little behind in the race, owing to the intervention of particular disturbing factors, may at once be admitted, but the true cause has been one that certainly does not tend to disquietude. For it was a pronounced case of *embarras de richesses*. All leading British manufacturers were so utterly "full up" of profitable work that they were absolutely unable to take any more for two years or so then to come. This was the sole reason why the Midland, Great Northern,

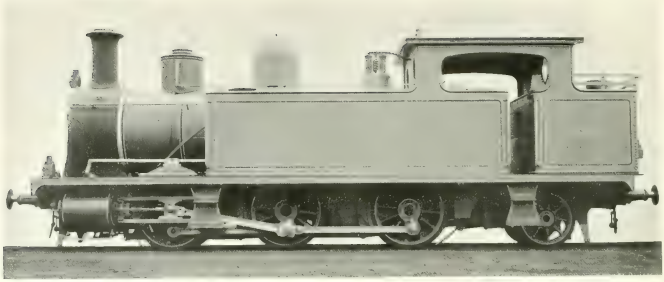


FIG. 2. EIGHT-WHEEL TANK ENGINE BUILT FOR THE IMPERIAL GOVERNMENT OF JAPAN.

Great Central and New Zealand contracts went to the United States of America.

The question of *results* does not enter into the scope of the present article. An infinity of nonsense has been talked and written on the subject with a view of proving either English or American methods to be incomparably the superior of the two, according to the bias of the disputant, whereas, in reality, there was not even an approximate test implied in the transactions Those English and Anglo-Colonial railways were in a "tight place" for want of locomotive stock, and had to procure supplies with the utmost possible expedition, no matter whence. Everybody who knew anything at all about the matter was perfectly well aware from the first that American engines, supplied in such circumstances and worked under purely British conditions, would necessarily prove uneconomical in fuel consumption and repairs, but that, given fair play, they would assuredly do their pulling all right. And so it turned out. There is no need here that I should enlarge upon the reasons why this should have been foreseen, or why it came to pass. Everyone who has studied the subject knows that the Americans admittedly, and of deliberate purpose, build their engines much more cheaply than we do in England. They do not want them to last so long as ours do; they deem it preferable to use them up quickly and build new ones with all the latest improvements, and they do not mind the burning of a little extra fuel or the somewhat larger cost of repairs, because, in their opinion, they make the engines pay for both.

On the other hand our British locomotive builders, if they do not build "for eternity," as has been said of our bridge builders, do at least build their locomotives to last more than the average length of a human life, while they finish them with the delicacy of an astronomical instrument, and naturally engines built with such perfection do prove alike more efficient, *per unit of theoretical power*, than do the more roughly built machines, and also more economical as regards fuel consumption and repairs. The sole point in which it seems to me, after a long and exceptionally varied experience, our British locomotives fall short of American, is that we do not give them so large an amount of power in proportion to the work they have to do. In other words, the British engines have fewer *units of theoretical power*, and consequently a smaller margin of strength in case of need.

STATUS OF BRITISH ENGINES.

This, however, is, of course, not an essential feature in British engines; it is rather the survival of the sins of our railway youth, a relic of archaism which I am glad to say is more and more rapidly becoming obsolete. But even were the case otherwise, the fact would remain that our British-built engines do possess great constructional superiority alike in material

and in workmanship, and this is so fully appreciated by most of the British colonies and dependencies, as well as by foreign nations, that if British-built engines can be procured within a reasonable time and at a reasonable price, they are almost invariably preferred to other builds. But this very fact in itself produces a new difficulty—the *embarras de richesses* already referred to. Our leading British makers are almost always so "full up" of orders, and have so vast an amount of work in hand, that they are often compelled to stipulate for longer time of execution than is needed by builders of less fame who are not so fully occupied. It was this fact which led to British orders being sent to America, and which compelled the colony of New Zealand, just at the time when its Government was most anxious to foster its trade with the Mother Country, nevertheless, to transfer its locomotive orders to the United States. New Zealand is perhaps the most thoroughly British and John Bullish and loyal of all the colonies, and the one most anxious to deal solely with the Mother Country, if possible. Yet I believe I am right in saying that New Zealand's stock of locomotives includes a larger proportion of American-built engines than that of any other British dependency. This is a very curious and suggestive fact, and it may be interesting to trace out the causes.

WHY NEW ZEALAND SENDS TO AMERICA.

Originally all the engines employed on New Zealand railways were of British build. They were supplied chiefly by Messrs. Neilson and Co., the Avonside Company, Messrs. Dübs and Co., R. Stephenson and Co., and the Vulcan and Yorkshire Engine Companies. When the time arrived for running passenger expresses, as none of the engines already in the colony were suited to such duty, it became necessary to procure a new type. This was taken in hand in good time before the completion of the through line, but it was found that no British builders kept in stock, or were prepared to provide at very short notice, the exact class of engine suited to that sort of work on the 3-ft. 6-in. gauge, with a very light permanent way—laid with only 40-lb. rails for a considerable distance—and somewhat steeply graded. On the other hand, locomotives of this class were ascertained to be readily obtainable from America, and accordingly thence came the first American shipment of locomotives to New Zealand—eight express engines constructed by the Rogers Company, of Patterson, N.J. The next urgent requirement was a type of goods engine capable of hauling heavy trains over the ruling grades of 1 in 50, with curves of $7\frac{1}{2}$ chains radius, that prevailed over the southern portion of the Dunedin-Christchurch main line. An eight-wheel coupled engine was manifestly indicated with wheel base flexible enough to enable the curves to be safely rounded. This obviously suggested the American type, known as the "Consolidation," namely, eight-wheels coupled, the two middle pairs being unflanged, and a Bissell bogie or two-wheel pony truck to lead. Here again an American firm—the Baldwin Company, of Philadelphia, had on hand precisely the article required, and shipped it to



FIG. 3. GOODS ENGINE FOR THE EAST INDIAN RAILWAY.

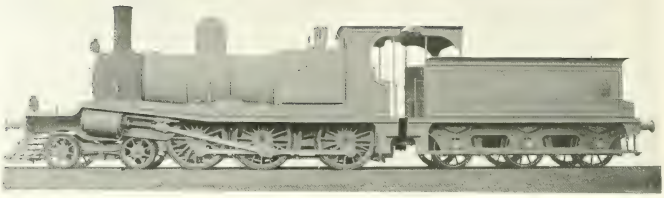


FIG. 4. ANOTHER USEFUL TYPE OF LOCOMOTIVE FOR INDIAN SERVICE.

New Zealand with a celerity of despatch and economy of expense that in those days seemed positively astonishing. Both classes of engines performed most satisfactory work without proving inordinately expensive in either fuel or repairs.

Nevertheless, notwithstanding this favourable result of these two initial importations, so strong was the "Motherland" feeling in New Zealand that there was great reluctance to import any but British-built engines, and accordingly several successive orders were subsequently given to leading British firms, including Neilson, Dübs, and Stephenson. But then there unexpectedly occurred a sudden expansion and congestion of traffic similar to that which overtook the British railways a few years ago and brought about the American importations hither. The train loads had outgrown the capacity of the original express engines, and the number of goods trains that required the most powerful engines to haul them had greatly multiplied. So twenty locomotives, ten of each class, were ordered from Britain. But in the first place the time required for execution was so much longer than had been anticipated, that there seemed every probability of a traffic deadlock before the new engines should be received, and in the second place through some strange oversight, which has never been fully explained, the first two engines of the order that were ready, turned out to weigh considerably more than had been anticipated, and also considerably more than the colonial bridges would safely support. This necessarily involved further delay, and meanwhile the traffic necessities had become urgent in the last degree, wherefore recourse was had once more to the United States, an order being cabled to the Baldwin Company for a number of engines having the same nominal power as those previously ordered from Britain. The result is a matter of history. The American builders saw their chance, and ran it for all it was worth. The engines were delivered in New Zealand within five months from the date of the cabled order, and at a cost of £400 per engine less than that which was to be paid for the British engines not yet to hand. Moreover, the American engines of both types, as in the former case, proved in all respects satisfactory.

THE PREPONDERATING FACTOR IN THE LOCOMOTIVE SITUATION TO-DAY.

It is not surprising that in these circumstances the New Zealanders should have felt that their salvation, or at least their security, lay with America rather than with Britain, and the consequence has been seen in the large locomotive importations to that colony from the United States which have since taken place, and which still continue. It is highly probable that other British colonies or dependencies may have had similar experiences, but I prefer to write of those which have come under my notice personally. There has been much resultless disputation on one phase of this question. Satisfaction has naturally been felt in this country that the sole reason why British builders have been out of various recent contracts, is that their hands were already full, that they had as much profitable work in progress already,



FIG. 5. TANK ENGINE BUILT FOR THE SANTANDER AND BILBAO RAILWAY, SPAIN—FOUR-WHEELED COUPLED FOR PASSENGER SERVICE.

or contracted for, as their existing machinery could cope with. But it was further held to be not worth while to erect additional machinery merely to grapple with a state of affairs which might be purely exceptional and emergent, and might not prove permanent, in which latter contingency the investment might prove unremunerative. To this it has been answered that American builders view the situation otherwise, and deem it judicious, economical and profitable to seize every opportunity that offers, to turn away no orders that can be secured, and to undertake them and execute them, even if this should involve extensive outlay in respect of new machinery. It does not fall to me on the present occasion to decide between these conflicting opinions; my part is merely to record them as constituting a preponderating factor in the locomotive manufacturing situation as it exists at the moment, and has existed for some years past.

WANTED, FAIR PLAY.

There is another side of the case which is less agreeable to touch upon. I do not desire to



FIG. 6. ANOTHER ENGINE FOR THE SAME RAILWAY—A TEN-WHEEL DOUBLE ENDER, WITH SIX WHEELS COUPLED.

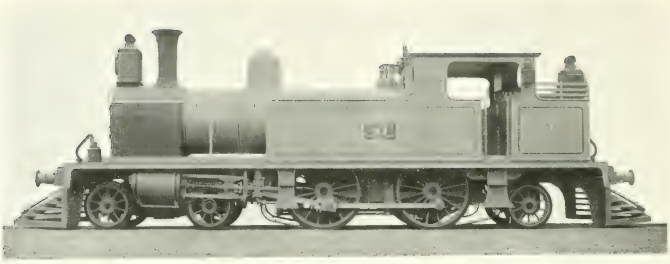


FIG. 7. HANDSOME TEN-WHEEL TANK ENGINE FOR THE BUENOS AYRES AND PACIFIC RAILWAY.

irritate national antipathies. But I am afraid it is undeniable that certain contracts abroad have been wrested from British competitors by means that cannot be characterised as fair. Certain recent instances are sufficiently notorious in which foreign contractors—European—have obtained contracts to supply locomotives to British dominions abroad by deliberately undertaking to do what they must have been well aware could not possibly be honestly done for the price named, and then, endeavoured to pass off inferior material and inferior workmanship in lieu of what their contract required to be given. It is manifestly unfair to British manufacturers that they should have to face competition of this class, and the only remedy seems to be for the inspectors to be absolutely rigid and uncompromising in the performance of their duty, performing it with entire independence, and ruthlessly condemning inferior work and materials "without fear, favour or affection." That British builders can compete successfully on an equitable basis I entertain no doubt whatever, provided only the obstacle of time does not stand in the way. But they will have to bear in mind that railway traffic will not wait for manufacturers, and that even the most prescient of railway authorities cannot possibly foresee what may be the requirements of a year or two in advance. There have, indeed, been instances of such attempted foresight on the part of a British colony, which resulted in a large proportion of the new rolling stock, hurriedly ordered, turning out a costly superfluity, owing to the sudden intervention of one of those periods of "bad times" to which even the most prosperous and progressive communities are occasionally subject. Consequently, if our British engine builders desire to retain in their own hands the cream of the colonial locomotive trade, they will have to hold themselves prepared for sudden and short-noticed demands; otherwise orders will assuredly go elsewhere, and may then continue so to do. They may deem this latter alternative preferable to the expenditure of large sums in adding to their appliances on the chance of such additions being needed. That is a matter for them to decide, but, unquestionably, unless they can make it suit their circumstances to hold themselves in readiness for such sudden demands, they will always be in danger of seeing good contracts pass them by.

BRITISH BUILDERS NOT YET PLAYED OUT.

Happily, there have not been lacking instances of late of our British locomotive manufacturers holding their own abroad, in spite of the certain measure of success which French and German builders had won in British dependencies. Two cases at once suggest themselves. Not long ago the State Railways of Belgium gave an order to the eminent Glasgow firm, Messrs. Neilson, Reid and Co., to construct a batch of powerful express engines according to the celebrated "Breadalbane," or "improved Dunalastair" design of Mr. J. F. M'Intosh, Chief Mechanical Engineer to the Caledonian Railway.

Still more recently the State Railways of Holland obtained from the same Scottish firm a batch of very fine express engines, of which one was shown in the Vincennes Annexe of the Paris Exhibition of 1900, exciting general admiration and being allotted the *grand prix*. More recently still, Messrs. Beyer, Peacock and Co., the well-known builders of Gorton, Manchester, have received an order from the Imperial Government of Japan for no fewer than twenty-four locomotives in one batch. This is all the more satisfactory, inasmuch as so lately as the end of last year a very important locomotive contract, involving a huge sum of money, had been given by the Japanese Government to some German builders. It was stated that several of the leading British, American, and German building firms had tendered for the contract, but that only the German tenders were accepted. Subsequently, however, it transpired that for some reason the order which had been given to Germany was rescinded, and was transferred to Messrs. Dübs and Co., of Glasgow, except so far as eight engines were concerned, which still were ordered from a German maker. However, it is satisfactory to note that both Messrs. Dübs and Messrs. Beyer Peacock and Co. secured very substantial contracts with the State Railways of Japan, perhaps at the present moment the most progressive Empire in the world.

WHAT BRITISH MANUFACTURERS ARE DOING.

At this stage it will probably be interesting to stray somewhat beyond generalities, and to enter into some fuller detail as to what our British builders have been doing of late. As the result of special inquiries, I find that a number of important contracts have been secured from various quarters of the globe by such well-known makers as, for instance, the three great Glasgow firms—which I take in their alphabetical order—Messrs. Dübs and Co., Messrs. Neilson, Reid and Co., and Messrs. Sharp, Stewart and Co.; also by Messrs. Kitson and Co., of Leeds, and the Vulcan Foundry, Newton-le-Willows, and perhaps, some others.

Messrs. Dübs have recently built for the Government Railway of Western Australia some very fine 12-wheel goods engines (fig. 1) eight-wheels coupled with leading four-wheel bogie; the coupled wheels are 5 ft. 6½ in. in diameter, the cylinders are 17 in. by 23 in., and the total heating surface is 1,394 square feet; the fire-box yielding 127 square feet; it has a working pressure of 175 lb. per square inch. The weight of the engine in working order is no less than 53 tons 7 cwt., exclusive of tender, although it is built to run on the narrow 3-ft. 6-in. gauge. It is accompanied by a double bogie tender which weighs 28 tons loaded.

For the Imperial Government of Japan, the same firm has constructed some very handy

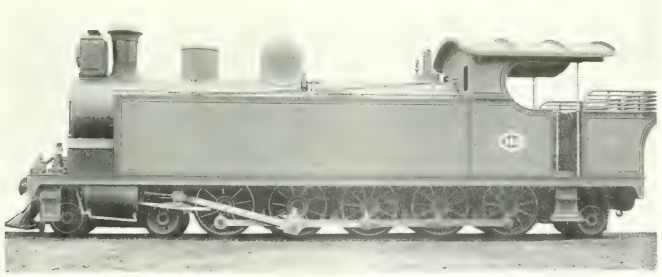


FIG. 8. EXTRA POWERFUL TANK ENGINE (SIXTEEN-WHEELER) FOR THE GOVERNMENT RAILWAYS OF NATAL.

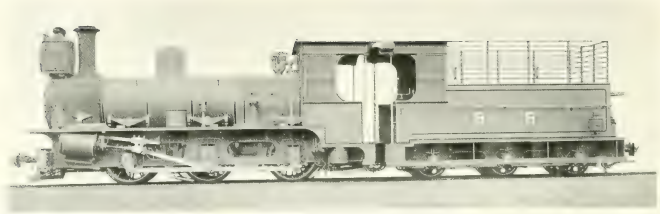


FIG. 9. SMALL LOCOMOTIVE FOR BURMAH.
The curious superstructure attached to the tender is for the purpose of holding a special kind of fuel.

eight-wheel tank engines (fig. 2), with 4-ft. 1-in. wheels, six-coupled, and trailing two-wheel bogie. The cylinders are 16 in. by 24 in.; total heating surface, 1,000 square feet, steam pressure 160 lb., the total weight of engine, loaded, 49 tons. These engines are also for the 3-ft. 6-in. gauge.

For the railways of India, which are on the 5-ft. 6-in. gauge, Messrs. Dübs have built two useful locomotive types. The first is for the East Indian Railway (fig. 3). It is a powerful and efficient-looking goods engine, entirely British in outside appearance, with six-coupled 5-ft. 1-in. wheels, inside cylinders, 18 in. by 26 in., 1,350 square feet heating surface, of which total 113 square feet must be accredited to Mr. D. Drummond's water-tubes that traverse the firebox. The engine weighs 44¾ tons in working order, and employs a steam pressure of 160 lb.; the tender tanks carry 3,000 gallons of water, while the coal bunkers have a cubic capacity of 240 ft. The second of Messrs. Dübs's (fig. 4) 5-ft. 6-in. gauge Indian types, is a sturdy looking ten-wheeler, with six-coupled 5-ft. wheels, leading four-wheel bogie, outside cylinders, 18 in. by 26 in., 1,288 square feet of heating surface, and 160 lb. of steam pressure. This engine weighs 52 tons 2 cwt., and the tender capacity is 3,000 gallons of water, 250 cubic feet of fuel.

Figs. 5 and 6 show two strongly contrasting types of tank engine, of which several have been built by the same firm for the Santander and Bilbao Railway of Spain. They consequently introduce us both to an entirely foreign country, and also to a fresh gauge, that of the metre, or 39·37 in. One is four-wheeled coupled for passenger service, and has 4-ft. 3½-in. drivers, outside cylinders, 15½ in. by 22 in., 772 square feet of heating surface, 150 lb. steam pressure, a water-tank capacity of 600 gallons, and a bunker space of 49½ cubic feet. The other engine is a ten-wheel double-ender, with six wheels coupled, 3 ft. 3 in. in diameter, and leading and trailing two-wheel pony trucks. The total heating surface is 943 square feet, the cylinders (placed outside) are 16 in. by 20 in., and the total weight of the engine loaded is 39 tons. The tank carries 850 gallons of water, and the bunkers hold 51 cubic feet of fuel.

Next in order among Messrs. Dübs and Co.'s foreign customers comes the Argentine Republic, with the Buenos Ayres and Pacific Railway for which they have constucted some handsome and English-looking ten-wheel tank engines, with four coupled 5-ft. 1-in. wheels, leading four-wheel bogie, and trailing two-wheel pony truck, outside cylinders, 16 in. by 24 in., 1,067 square feet of heating surface, 175 lb. steam pressure; total weight in working order, 57¼ tons. These engines are built for the same gauge as that of the Indian railways, namely, 5 ft. 6 in. The type is shown in fig. 7. I may add that they are fitted with Mr. D. Drummond's water-tubes in the firebox.

South Africa is also the recipient of some of Messrs. Dübs's manufactures. For the Government Railways of the Colony of Natal, which are constructed on the narrow 3-ft. 6-in. gauge, they have built an extraordinarily powerful tank engine, which runs on no fewer than sixteen wheels, ten being coupled, with a leading four-

wheel bogie and trailing two-wheel pony truck. The ten-coupled wheels are 3 ft. 9 in. in diameter, the cylinders are as much as 19 in. in diameter, with a 27-in. piston stroke, and the heating surface amounts to 1,493 square feet, while the steam pressure is 175 lb. per square inch. This huge engine weighs 70 tons 18 cwt., and is probably the largest and heaviest yet built for the 3-ft. 6-in. gauge. (Fig. 8).

An order has also been executed by the same builders for the railways of Burmah, which are constructed on the metre gauge. These engines possess the peculiarity of having outside bearings and outside cranks to the coupled wheels, together with outside cylinders. The cylinders are 14 by 20, the six-coupled wheels are 3 ft. 6½ in. in diameter, the total heating surface is 650 square feet, and the steam pressure, 150 lb. The engine is a small one, weighing only 24 tons 13 cwt.; it is shown in fig. 9, and it will be observed that the tender is fitted with a very curious superstructure for the purpose of holding a special kind of fuel. The enormous headlight in front of the chimney also tends to give this engine an unusual appearance.

But the Scottish firm was not content with supplying Western Australia, Japan, India, Spain, the Argentine Republic, Natal, and Burmah, but has also gone so far afield as China, and has carried out a contract for the supply to the Imperial Chinese Railway of a number of engines of the so-called "Mogul" type, with six-coupled driving wheels, 4 ft. 6 in. in diameter, and leading pony truck. The cylinders, which are outside the frames, are 17 in. by 24 in., the total heating surface is 1,196 square feet, and the steam pressure as high as 180 lb. per square inch, while the weight of the engine in working order is 44 tons 16 cwt. (See frontispiece.)

Even this list of recent constructions is sufficient to show that our British builders are not yet "played out." In a subsequent article, I shall give, on a similar basis, particulars of locomotives lately turned out by the other two Glasgow firms referred to—Messrs. Neilson, Reid and Co., and Messrs. Sharp, Stewart and Co.—as well as by Messrs. Kitson and Co., and the Vulcan Foundry.

(To be continued.)

CORRESPONDENCE.

"WIRELESS" TELEGRAPHY.

To the Editor of PAGE'S MAGAZINE.

DEAR SIR,—

In connection with Mr. de Segundo's paper on "Wireless" Telegraphy which appears in the April number of your magazine, it may be of interest to some of your readers to hear that when I visited Honolulu in January of this year, I found the "wireless" system being used there with much success. The islands of Hawaii are seven in number, and they have been an American colony since 1897, I believe. I was told that all the islands had been connected by "wireless" for some time, in fact, ever since Mr. Marconi's discovery was proved practicable. The distance from island to island is in some cases about twenty miles, and in others as much as about seventy-five. The system is working very satisfactorily, and is of great value to many of the business men who have their offices in Honolulu, on the island Oahu, and their sugar plantations on distant islands. On the island Oahu nothing but telephone is used. The cable connecting Honolulu with San Francisco was laid down by the cable ship *Silvertown*, and completed on December 31st, 1902. Unfortunately, I have no official or technical figures of the working of the wireless on these islands with me.

M. C. CLARK GOMM.

The Laying Out of Engineers' Workshops.

BY

JOSEPH HORNER.

This article deals with the designs of the walls and roofs of workshop buildings.—Ed.

IV.

THE ground plan of the works having been settled, the next matter to be considered is the construction of the shops. This includes the general design of the buildings, and also the particular arrangements which are required in the separate shops, such as those peculiar to the foundry, machine shop, boiler shop, etc. We propose to take up the latter individually at a later stage in this series. They do not touch materially the general problems of buildings, which can be settled in the main irrespective of these details. In approaching this general subject, the two questions that naturally call for first consideration are the structural design of the walls and roofs, and then the questions of floors, of light, ventilation, sanitation, etc.

HOW HOISTING TACKLE AND SHAFTING AFFECT THE DESIGN OF WALLS.

Before settling some of the principal details of the walls the requirements of the interiors of the shops have to be considered. Two most



GENERAL VIEW, CARBON WORKS, GENERAL ELECTRIC COMPANY, LTD., WELTON.

important matters, which apply to several shops alike are the hoisting appliances, and the shafting. As the strains on heavy hoisting tackle are transmitted to the walls, these have to be made stiff enough to stand them, besides sustaining the load due to the roof. Overhead travellers are generally carried on girders supported on columns, or on buttresses, or on corbels. Buttresses fulfil the double function of supports to the travellers, and of stiffeners to the walls. Swinging cranes require the support either of stiff buttresses or of columns.

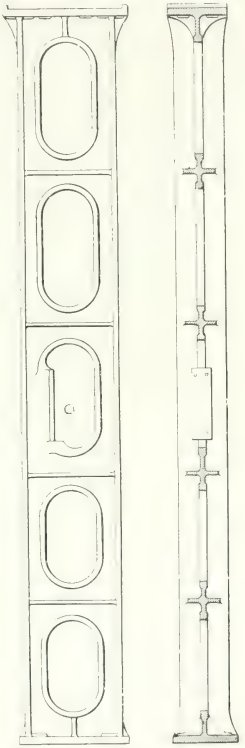
The shafting affects the design according to whether the main line is to run down the centre, or along the sides of the shop. The former plan is not permissible in shops where a traveller has to be installed because it would block the movements of the latter. But it is suitable enough for light machine shops, and then buttresses or corbels must be built in, or columns erected to carry girders or brackets for the shaft bearings.

Line shafting is also carried at the sides of shops, down which a traveller runs, the shaft bearings being suitably attached either to brackets on the walls or on the columns. This does not admit of the convenient use of very large driving pulleys, but pulleys of small and medium diameters can be carried thus without projecting so far as to interfere with the movements of the traveller. The drive to the counters is then, of course, either vertical, or nearly so. Very often the line or the countershaft runs through columns, or beneath traveller girders.

The storied building offers no difficulty with regard to the fixing of shafting. The joists which carry the floors are utilised for bolting planks up to receive the shafting bearings, often for both those of the line and counter. Then the belts run horizontally from one to the other, and vertically from the counters to the machines. In such shops there is seldom any hoisting tackle required to interfere with belts. In some cases the roof principals have to sustain the main line of shafting, in others a system of overhead tracks has to be suspended from them. In such cases these attachments must be provided for in the original design, if the work is to be carried out in the simplest and most satisfactory manner.

WALLS AND COLUMNS.

There are two systems of building factory walls: one, the older, in which brick, or stone is used wholly; the other in which a steel



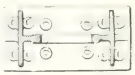


FIG. 1.



ENGINEERS' DEPARTMENT, GENERAL ELECTRIC COMPANY, LTD., WITTON.

skeleton either has its interspacing filled in with, or is enclosed with, bricks. Such filling in, or covering is subsidiary and secondary to the columns, the latter alone sustaining the roof, hoisting tackle, shafting, and portions of machines. The walls need not be thicker than the length of a brick —nine inches. They are chiefly a protection from the weather.

In those cases where columns are used with a brick interspacing in walls, the result is to cheapen the cost. With the column pattern for the roof supports of open bays, the same can be used for the outer walls. The cost is not only lessened, but the columns afford better means of attachment than brick walls do. The walls in such a design carry nothing (minor small shop fittings excepted), they merely fulfil the same function that corrugated sheet does in some buildings, only in a more substantial, comfortable way. The whole of the weight of the roof is borne by the columns; so is that of cranes and machines.

A great advantage in the use of steel throughout for columns and roof principals, apart from its combined strength and lightness, is that the whole of the skeleton work of a building can be completed in steel before joiners, plumbers, slaters, and other craftsmen come on the job.

In such a design longitudinal extension is easy. Fresh columns can be added, the roof extended, and the walls filled in. Another point is that columns afford excellent means of attachment for the pipes which are used for heating and other purposes in many modern shops.

Sometimes the steel skeleton is not even bricked in, but simply covered with corrugated galvanised sheets. This, however, is not to be recommended except for temporary structures. In view of possible future extensions the sheet iron building has the advantage of being easily removed or remodelled. That, and its cheapness, and rapid construction, is all that can be said in its favour. For temporary service it is the only kind available. By temporary service is meant the erection of, or extension of a shop during such period as a better site is being secured, or until the lease of such a site falls in. The temporary service in such cases may run into a few years. The great objection to such buildings is the extremes of temperature in summer and winter, the sheet iron affording little protection excepting from winds. But platers and boiler makers are glad even of this protection.

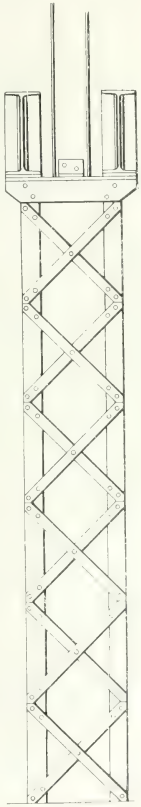


FIG. 2.

Sometimes one sees a great deal of match-boarding as well as masonry used in the walls of shops. Thus, if columns afford the main support, the intervals are filled mainly with brick or with timber, or with corrugated sheets, and here and there a window. Or the space between the traveller runway and the roof is boarded up. This has an unsightly appearance both from within and without, and it blocks light. Add to this heavy timber trusses, narrow and short skylights, and we have a good object lesson of how not to do it.

COLUMNS.

Columns are either cast, or of rolled sections, or steel-plated, or lattice-braced. In the main, the choice of one or the other kind is of not much importance. Each type is very suitable for certain conditions, but the question is, perhaps, in the main, often



ERECTING SHOP AT THE WORKS OF MESSRS. MATHER AND PLATT.

reduced to one of the relative cost—castings costing less or more than plated work in different districts. Or the choice may be determined by the firm's own facilities for manufacturing either design.

periods. Fig. 1 is a type in frequent use, the only modifications required being those that are made to suit positions of shafting, or swinging cranes, arms of radial drills, etc., which may sometimes entail casting brackets and

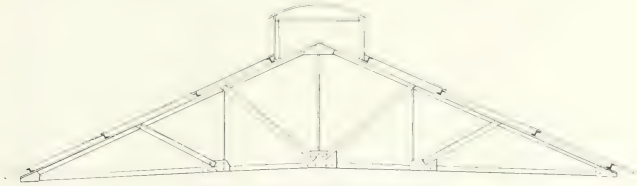


FIG. 3. RIDGE ROOF WITH LOUVRE.

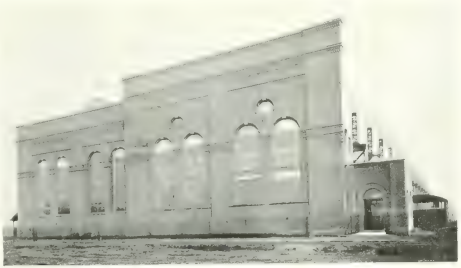
In most cases the round cast column is the worst form to adopt, either for the walls, or for the separation of bays. In several cases these have caused trouble in the attachment of portions of machines to them—such as radial drills, cranes, etc., the installation of which was not contemplated when the shop was built; and countershaft bearings, and striking gear also furnish common examples of this kind of attachment. Round columns of cast iron are of most value in shops which deal with light work, where the questions of heavy machinery and of tackle do not arise. They are most suitable for storied buildings, and in sub-sections of a big single-floor factory, but they are not the best for the big shops, nor for those which are mainly equipped with machines. When such columns are used in main bays, cantilever brackets are generally cast on them to support the traveller girders, or shaft bearings; or flat facings can be cast on, and brackets bolted to them.

In all other cases the column of rectangular cross section is the best to adopt, because its flat faces afford convenient means of attachment for machines, shaft bearings, and anything requiring fixing at future

facings on in different positions. In the figure a facing for a shaft bearing is shown about half way up; the position of the shaft, inside the columns, being the least inconvenient method, as it does not come in the way of the travellers.

CAST IRON *versus* STEEL PLATED COLUMNS.

With regard to the choice between castings of square sections, or of steel-plated work, or rolled sections, each is largely employed. The use of the first-named permits of effecting attachments at will. There is usually more rigidity about cast than plated work, and it should therefore be more suitable for shops where a lot of heavy machinery is running. There is no objection to cast iron in this application, since it is either in



END VIEW OF WORKS. GENERAL ELECTRIC COMPANY, LTD., WITTON.

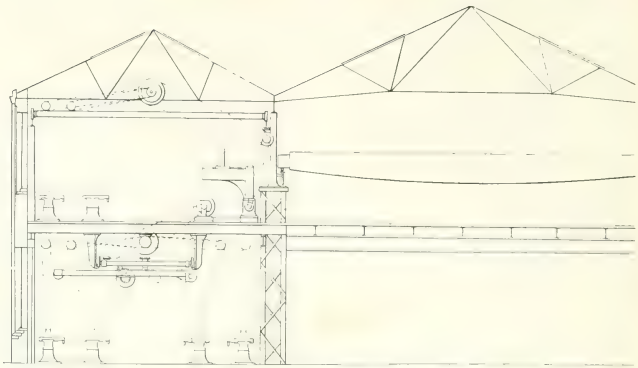


FIG. 4. SECTION THROUGH THE SHOPS OF MESSRS. KENDAL AND GENT.

direct compression, or is subject to simple bending stress, both of which stresses it is eminently adapted to withstand. And there is practically no trouble due to bad coring, as there may be in circular columns, since the columns are generally of H section, with little or no coring of any size. But after all these matters are considered in favour of cast columns, the built up steel ones are, on the whole, to be preferred to them.

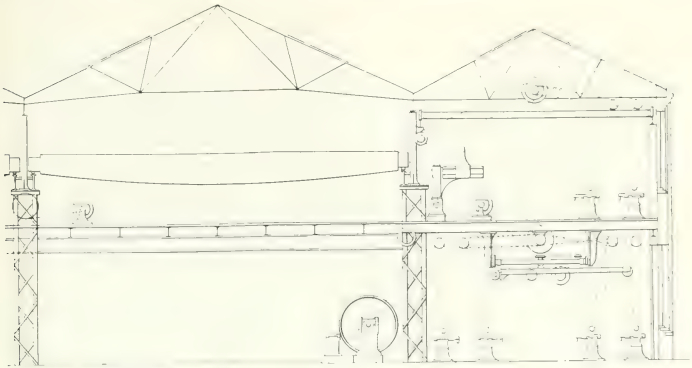
BUILT UP COLUMNS

Plated columns, or stanchions, are used extensively for machine shops, boiler shops, smithies, erecting shops, and for foundries. The simple rolled H section is used in small bays. In larger forms the section is built up of an H and two flats riveted together, to extend the flanges; or one H and two channels may be riveted together. Enclosed box sections are not so desirable because of the difficulty of renewing the paint in the interior, to permit of which a number of hand holes must be cut. In using these labour is saved, but the appearance is heavy, and the solid plating is not so useful as the lattice, which should generally be preferred to solid plated ones. One of these is shown in fig. 2, carrying two traveller girders for adjacent bays on top, and a lighter solid roof stanchion. The latticing is varied in the manner of crossing, many types being of simple zig-zag form, instead of crossed strips, as shown in the figure. All the common steel stanchions are used in buildings, ranging from the simple rolled H section to the built up forms. In many cases it is necessary to use open forms to permit the shafting, or sometimes piping, to pass through—another reason why this is to be preferred to closed box sections.

With regard to the strength of the columns and girders on which the travellers run, these have to be calculated with reference to the travelling cranes when fully loaded. In cases where two cranes have to make a joint lift—a familiar example of which is found in locomotive shops—any two columns and the girder should be capable of sustaining this joint load, with a good margin of safety.

BRICK WALLS WITHOUT COLUMNS

Walls, especially those of foundries, are frequently built of brick, without columns, the tracks for the overhead travellers being carried on buttresses or corbels. But there is no shafting required in the casting areas of a foundry, which renders the choice of brick alone more suitable here than it would be in a machine shop or turnery. And yet there is no necessity for



VICTORIA WORKS, MANCHESTER.

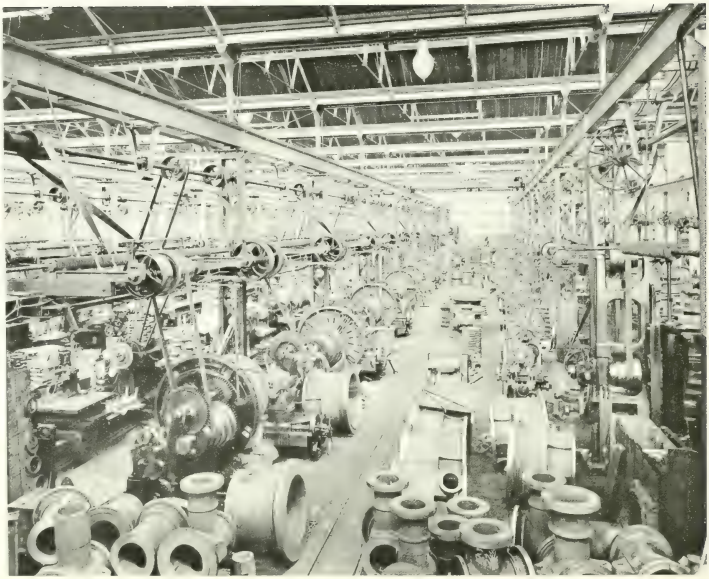
building wholly of brick, excepting custom. Many new foundries have been constructed on the same design as machine and other shops, with steel columns and brick filling.

ROOFS.

Roof designs are very numerous. The two chief requirements that should be satisfied in a roof, after its stability, are the exclusion of weather, and the admission of light. A slated roof is the best of all. One of sheet iron is not uncommon, but is not a pleasing nor quite satisfactory type. Tiles increase the weight on roofs of large span more than is desirable, and should not be used for large areas. In recent shops more care has been bestowed on roofs than formerly, particularly in the insertion of a waterproof felt between the slates and a lining of matchboarding, or a stout backing of wood. This adds greatly to cost, but is true economy in the end. In some old works leaky roofs keep a slater regularly employed in winter, especially after heavy falls of snow, or high winds. This is often due to the use of zinc nails for fastening the slates instead of those of copper. Sometimes it is due to the warping of timber principals. But leakage would often be prevented in such cases if a lining of board and an intermediate lining of waterproofing had been used. But by whatever means attained, a roof must be sound, or much damage to machines and to foundry moulds and other work will result in stormy weather.

THE RIDGE ROOF.

The general type of roof employed is the common ridge roof, sloping down at equal angles on each side. As now built, it is often of steel. Those of timber are sometimes preferred, and even for foundries, on the ground that the sulphurous fumes cause deterioration of steel, but do not injure wood. But it seems likely that the time for timber roofs in new works is nearly gone by, if for no other reason than that they block light and hold dust, and require frequent whitewashing; and, of course, fire risks are increased. In the early days of roof-building, when iron had not as yet been supplanted largely by steel, the various tension rods were frequently of round bars. At the present time, angles, tees, channels, and flat bars are preferred, the latter for tension members, the former for those in compression. When provision has to be made for shaft bearings or overhead tracks, channels or angles should be used for the horizontal ties. Roof principals can be cheaply constructed of steel angles, and flats, cut to length with a cold saw by the aid of templets, the holes being also



MACHINE SHOP OF MESSRS. WILLANS AND ROBINSON, LTD., AT RUGBY.

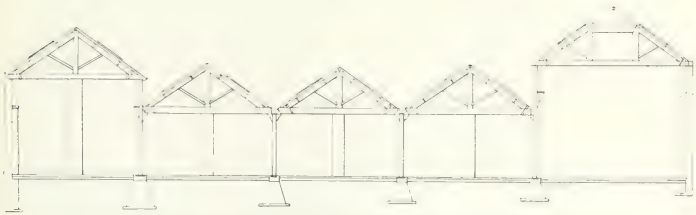


FIG. 5. SECTION THROUGH MACHINE SHOPS OF MESSRS. C. REDMAN AND SONS, HALIFAX.

drilled to templets. In the roof in fig. 3 the tension members are of flat bars and round rods, and those in compression of angles. The roof is of corrugated sheets and a sky-light runs down the middle of each roof. The top of the louvre is covered with arched corrugated sheets. Both wood and steel are used for roof purlins, the latter being preferable, filled in with wood; —L, T, or [sections are used for these.

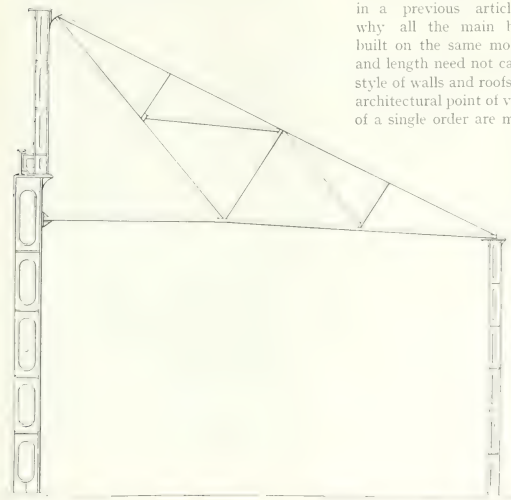


FIG. 6.

It is well to design all the roofs in works with some regard to uniformity. This is not merely a question of æstheticism, but also one of economy in getting out quantites. The larger the order for a given class of material or scantling, the better the bargain that can be made, for the problem approaches that of standardisation. And the question of harmony and uniformity should not be neglected in design. As mentioned in a previous article, there is no reason why all the main buildings should not be built on the same model. Differences in span and length need not cause any alteration in the style of walls and roofs and windows. From an architectural point of view, the historic buildings of a single order are more beautiful than those of the Renaissance, in which imitations of Classic and Gothic models have been united, to the debasement of both. And the factory ideal is a uniform style, in which massiveness and simplicity are the leading elements. This is attained in the solid brick enclosed building, and light, airy roof of steel.

Louvres over the ridge of the main roof are often placed there for ventilation, boards being fixed, as is generally done in foundries, or windows intended to

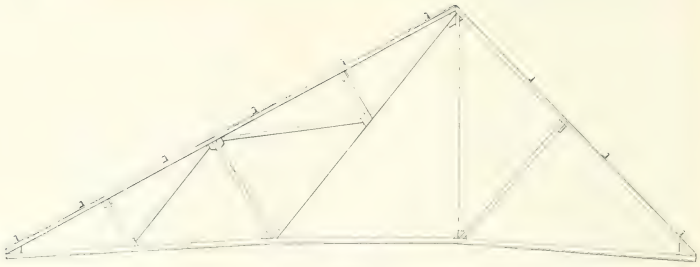


FIG. 7.

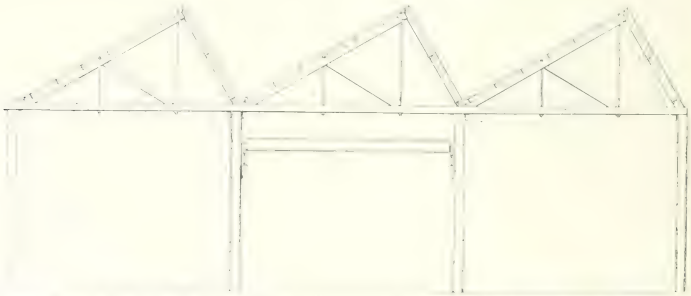
be opened for the purpose. But all shops do not include them, though they are desirable, and in their absence provision should be made for ventilation by windows at the sides and ends.

Roofs are usually carried on light columns or stanchions, bolted to the top of the main ones (see fig. 6). It would not only be a waste of material to carry the large sections beyond the traveller beams, but would shorten the available space for travellers, and block some light. The crane girders are also generally placed upon the top of these main columns, and a solid support taken, which could not be done so well if the columns were carried upwards farther. The same pattern of column can be used, though of reduced section, and cast, or rolled, plated, or lattice sections are therefore employed. This detail is shown in figs. 4 and 5, in the side bay of a shop, and in the main bays respectively.

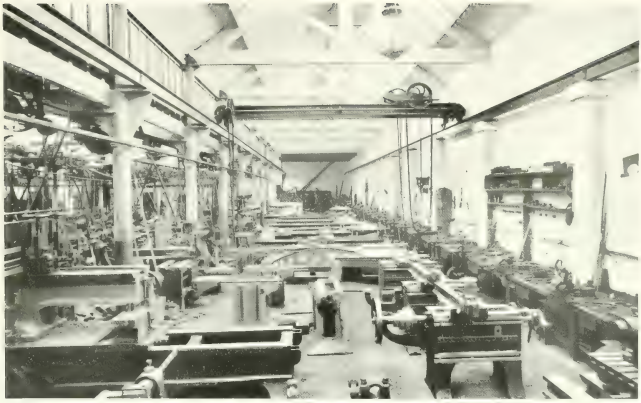
THE SAW TOOTH ROOF.

The saw tooth roof is used in a considerable number of new shops, though the type itself is not new, having been employed in weavers' factories. To those whose eyes are not offended by unsymmetrical outlines, this roof has the great advantage of preventing the glare of direct sunlight from coming into the shop, since the glass is always placed on the north side of the roof. A strong light without glare is ensured by this design, but, of course, it renders necessary the laying out of the roofs due east and west, or approximately so.

No very strong case can be made out for the



[illegible] MACHINE SHOP OF MESSRS. [illegible] AND [illegible], WEIR, LTD., GLASGOW.



A BAY IN MESSRS. C. REDMAN AND SONS' MACHINE SHOP, HALIFAX.



A WELL-LIGHTED SHOP IN THE WORKS OF THE ENGLISH ELECTRIC MANUFACTURING COMPANY, LTD., PRESTON.

saw tooth roof for engineers' shops in England. Direct sunlight is uncertain and transient in our climate. Abundance of light is so essential that it is better to suffer some brief inconvenience in summer time than to diminish the supply in winter. And even with the saw tooth roof, direct sunlight will enter in the morning and afternoon, unless walls are made without windows, and this design certainly cannot be considered as judicious. Too much light in shops cannot be had. An imperfectly lighted place is an expensive one. Glass is as cheap as bricks, or slates; and, exceptional cases apart, windows should be inserted in sides and ends of shops, as well as in the roofs. I would not have less than from one-third to one half of the floor area occupied with glass in walls and roof, so that there shall be no dark areas or corners calling for artificial light on dull days, or affording shelter to little knots of men. Fig. 6 illustrates a saw tooth span built up of angle and flats. The roof was lined with wood covered with waterproof material, on which the slates were laid—a detail not shown. The north side was glazed entirely over.

THE ARCHED ROOF.

In this type of roof, which is used to a certain extent, the arched form is built with timber trusses. It forms a stiff strong roof, but blocks out more light than steel. This may be compensated for by side windows. The horizontal member may be made as a flitch beam, with channel or H sections filled in with timber. The skylights are of the ordinary form. A firm who make a speciality of this form of roof are Messrs. D. Anderson and Son, Ltd., of Belfast, a felt covering being used instead of iron, or slates. Such roofs can be made cheaply, compared with the other types which have been discussed, and are suitable for spans up to about 100 ft.

HEIGHT OF SHOPS.

A matter in regard to which better practice exists than formerly is in the height of shops. Many of the old shops were built too low to permit of giving ample room to sling work below the lifting tackle, of the loss of light, and of ventilation. In shops that deal with light articles only, the tall shop of wide span is unnecessary. Either the storied building is suitable, or else a series of small bays each covered by its own roof. An example of this is shown in the shops of Messrs. Redman (see page 517). Such matters should be well considered and estimated, because the total weight of steel in a large works runs into enormous quantities.

ILLUSTRATIONS OF SHOPS.

The cross section through the shops of Messrs. Kendal and Gent (page 514), of the Victoria Works, Manchester, shows a brick building, with the bays divided by lattice braced pillars that carry the girders for the travelling cranes. Light stanchions above support the roofs, which are of steel, lighted on both sides. An end gallery runs along the main bays, the floor of which is carried on joists of H section. The side bays have two stories, both for machine tools, and served by overhead cranes. The lower crane is a curious one, being at once a travelling and a jib crane. The jib can be pushed along between the belting, and withdrawn again, and travelled down the shop. It does not, therefore, interfere with the overhead belts as a traveller of full span would do.

Fig. 5 shows the cross section through the machine shops of C. Redman and Sons, of Halifax, a plan of which was illustrated in our last issue. Here the outer walls are of brick, with buttresses, and the divisions between the shops are cast iron columns on concrete bases. The roofs are timber framed, ridge pattern, with skylights running the entire length on each side. Windows also run round the side walls.

Fig. 8 illustrates the sectional form of the machine shop of Messrs. G. and J. Weir, Ltd., of Glasgow. There are eight similar bays, each 25 ft. wide, and 320 ft. long. The uprights are of steel H sections, the outer walls of brick. The roof is of the saw tooth type, the north side being glazed all over. The roof principals are timber-framed.

OUR BIOGRAPHY OF THE MONTH.

SIR WILLIAM H. WHITE, K.C.B., F.R.S.,

President-Elect of the Institution of Civil Engineers.

THE career of Sir William H. White, K.C.B., F.R.S., until recently Assistant-Controller of the Navy, and Director of Naval Construction, is of unique interest to engineers, and indeed to Englishmen generally; for he may be said to have practically created the modern British Navy. Born at Devonport in 1845, his connection with Naval affairs began at an early age. Entering the Royal School of Naval Architecture, he quickly gave proof of exceptional ability, and was awarded the diploma of Fellowship (First Class). His connection with the constructive department of the Admiralty dates from 1867, and within a period of sixteen years he rose step by step to the rank of Chief Constructor, which position he held until 1883, the ensuing two years and a half being devoted to the organisation and direction of the warship building department at the works of Messrs. Armstrong and Co.

In 1885 he accepted office again as Director of Naval Construction, and was appointed also Assistant-Controller of the Navy, a new title which has not been continued to his successor at the Admiralty. Prominently identified with the various technical institutions, he recently received an honour such as falls to the lot of few men, in the shape of a letter signed by the presidents of the five leading engineering societies, expressing their desire to in some way show their appreciation of his work for the country and the Navy. In March last, this culminated in a complimentary banquet to Sir William at the instance of the Presidents, Vice-Presidents, and Members of the Council of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Electrical Engineers, and the Iron and Steel Institute. At this brilliant gathering a fitting tribute was paid to the genius of Sir William White, the Chairman (Mr. J. C. Hawkshaw) remarking that a man who had devoted the best years of his life successfully to designing such ships as Sir William White had produced, deserved the gratitude, not only of his friends, but of every one of his countrymen. Sir William White, in the course of his remarks on this occasion, referred to the great change that had taken place since he went to the Admiralty thirty-six years previously. His period of service was split into two sections—from 1867 to 1883; and from 1885, on the retirement of Sir Nathaniel Barnaby, when Lord George Hamilton found Time out and asked him to go back. There had been various naval programmes, and many millions had been spent freely. They were always looking for a return to the normal condition of expenditure, and hoping that the conditions of life would be easier, but that had not come about, and he did not suppose it ever would. One opinion they held in common, and that was, there must be no mistake about the Navy, because the power of the Navy must be beyond all question. Viscount Goschen, on this memorable occasion, said that "he doubted whether a greater compliment had ever been paid to a naval architect than that paid to Sir William White that evening. Sir William had proved himself one of the most energetic and most useful public servants. His energy had been unparalleled, his industry unsurpassed, and he had worn himself out in the service of his country. He never knew a man who was more able to find his way through the intricacies of Admiralty accounts than Sir William. It was a great thing to compete against the world in naval construction, and to receive but most favourable criticism in the critical institutions. We may add that there could be no higher tribute to the skill of Sir William White as a designer of war vessels.



Photo by Lafayette.

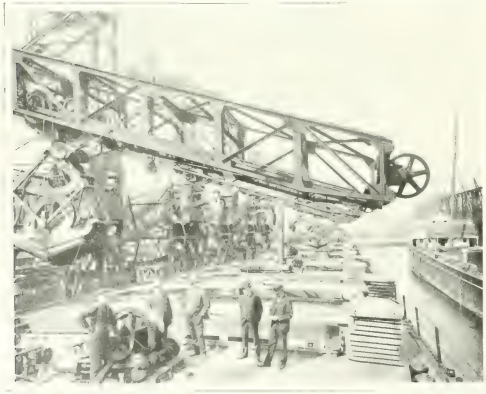
SIR WILLIAM H. WHITE, K.C.B., F.R.S.

SOME RECENT PUBLICATIONS.

"AMERICA AT WORK."

By John Foster Fraser. 262 pages. 8vo. With 38 plates. Cassell and Co., Ltd. 6s.

A THOROUGHLY readable volume, giving in short staccato sentences an impartial view of America at work. The reader, however, is apt to get the impression that work in America resolves itself into a mad pursuit of the "Almighty-dollar." Mr. Fraser has brought to bear upon the inner life of New York, Chicago, Pittsburg and other great centres of industry the keen eyes of the trained observer, and one realises painfully behind the personality of the successful American money-maker, the strain and stress of a system that wears men out long before life has run its allotted span. But we suppose that the following is not intended to be taken seriously :—



THE BRIDGE AND MASON GEAR.

[illegible] In the picture the [illegible] can be seen upon [illegible] travelling by a regular man, and not a specimen from [illegible] at the [illegible] building.—*From "America at Work."*

"Where are your elderly workmen?" I asked a Philadelphia manufacturer, once, twice, three times.

At the third time he opened his cigar-case. With a careless smile he said, "Have a smoke, and we'll take a car-ride along to the cemetery."

As the author says, you cannot generalise about America, but the following observations taken at random, tend to show that in some respects America should "wake up":—

[illegible] Bridges [illegible] another [illegible] year in America for excellence.

In the arts no country [illegible] itself so great an injustice as America.

"The United States Post Office is as slow as that of Russia.

"The thing beneath contempt is the telegraph system of the United States."

Mr. Fraser, however, finds many things to approve and admire, more especially the labour department, and the free access which is afforded to Government offices at Washington, business organisation, agricultural colleges and experiment stations, etc.

STEEL INDUSTRY.

A chapter is devoted to scenes in Pittsburg and the steel industry. It is remarked that British manufacturers have little to fear just now. But when the slump comes in the States, when the manufacturers find they have a surplus to get rid of; that will be the day when the British manufacturer will have a rude awakening! The competition will be relentless, savage, and there will be little consideration of humanity in it. The country with the best brains, the best machinery, and the cheapest transit will win.

The first thing Mr. Fraser noticed in the Carnegie Works at Homestead, was the scarcity of men about. "Yet there were thousands. Men sat in little cabs near the roof with tiny levers, and electric power did the rest." It was, however, during his visit to the Westinghouse shops that the author realised without the shadow of a doubt that the old order of toil is absolutely passing away; that the great worker is the machine, and man only the overseer.

RAILWAY FACILITIES.

Mr. Fraser concedes that railway travelling in America is more luxurious than it is in Great Britain, and bestows a word of praise on their system of collecting luggage. The American, he says, "scoffs at our first, second and third class system in England—

'Why,' he will tell you, 'in God's own country we're all equal, and we have just one class.' He does'nt, however, say you start by paying nearly the equivalent of third class, and if you want to travel well and express you must pay extra, and then probably another extra.

As to speed, the American talks much about the enormous rate at which his trains travel. But, striking an average, they are far slower than the British. America has several really magnificent trains that maintain a speed of between fifty to sixty miles an hour. You have, however, to pay an extravagant price to journey on them.

I travelled thousands of miles by ordinary 'express' trains, and the rate was about thirty-five miles an hour. Again, the trains were, as a rule, so unpunctual that I found myself removing some of the maledictions I had piled on several of our English railway systems. During the whole course of my tour, only twice, when the distances were over a hundred miles, did the trains arrive in time. Twenty minutes, three-quarters of an hour, even an hour late was not unusual.

Though in the case of specially expensive trains, the American railway companies beat ours in regard to speed, we beat them in ordinary general passenger traffic, and we would beat them hopelessly if there was less dilatoriness at English railway stations, and so much time were not lost examining, punching, and collecting tickets. In a phrase, travelling in England is cheaper and quicker than in America.

AMERICAN WORKING MEN.

An interesting chapter is devoted to American working men. The author notes that "man for man, on the quality of the work turned out, the Briton is the superior of the American. In America, the skilled workman is not required. What is required is: first, the man who can devise fresh labour-saving machinery; second, the labourer who will do one little routine thing year after year, and do it expeditiously. And in both of these things the American is ahead of the Briton."

In his general conclusions he remarks—

If the preceding chapters of "America at Work" teach anything, they teach that if success is to be attained in business, conservative ways must be abandoned.

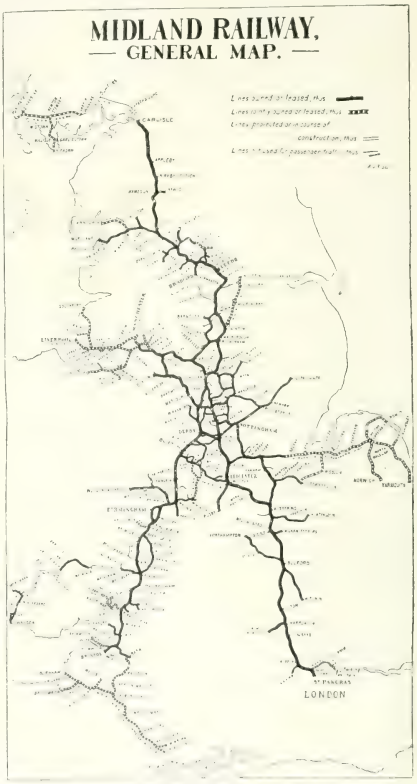
"America at Work" makes good reading, and we can unhesitatingly recommend it to the attention of those who are interested in our struggle for trade supremacy.

"THE RAILWAY YEAR-BOOK FOR 1903."

Sixth year of publication. Compiled and edited by G. A. Sekon. The Railway Publication Co., Ltd. 2s. 6d.

THIS well-known *vade-mecum* of British Railways makes its appearance this year in an improved form. A number of excellent maps, each devoted to a single railway, have been included, and vary in size according to the extent of each particular line. For instance, the map of the Midland Railway Company, of which we give a reduced facsimile, is a large folded map. Strenuous efforts have been made

to standardise the information concerning each of the principal lines, and many new tables have also been added. "The Railway Year-Book" well maintains the useful features of which we have become accustomed, and should find a place in the office of every up-to-date business man.



REDUCED MAP OF THE MIDLAND RAILWAY SYSTEM.
From "The Railway Year-Book for 1903."

"VENTILATION IN MINES."

By Robert Wabner. Translated from the German by Charles Salter. With thirty plates and twenty-two illustrations. Scott, Greenwood and Co. Royal 8vo., cloth, 10s. 6d. net.

SINCE the death of Theophil Guibal a great deal of ingenuity has been brought to bear upon the important question of mine ventilation, and our knowledge of gases inimical to the work of the miner has increased with the progress of chemistry. It is not surprising, therefore, that the author of the above work has found a good deal to add to the work of Guibal, more especially in connection with respiration, rescue apparatus and the cooling of mines at great depths. We have rarely seen more interesting plates than those which are bound up at the end of the volume. A coloured illustration shows the appearance of the Wolf benzine lamp flame in the presence of different percentages of fire-damp. Then we have drawings illustrating various kinds of rescue apparatus, pressure gauges, ventilating shafts, fans, etc., including large ventilators and new types of centrifugal fans of small diameter and high working speed. The author first considers the causes of the contamination of pit air. Chapter II. deals with the means of preventing the dangers resulting therefrom. In Chapters III. and IV. are discussed important calculations necessary to determine the required volume of ventilating current and the resistance opposed to the passage of air through the pit. The author then passes in review the various means of providing a ventilating current, and shows how the latter may be distributed through the workings in the most economical manner.

NOTES AND NEWS.



LAUNCH OF THE ARGENTINE CRUISER "MORENO."

The armoured cruiser *Moreno*, launched at the building yard of Messrs Ansaldo, at the Sestri Ponente, near Genoa, for the Argentine Navy—is sister ship to the *Rivadavia*, launched from the same yard last October. These two vessels belong to the *Garibaldi* class, of which type four ships have already been completed from the same yard, viz.: *Garibaldi*, Argentine Navy, with cylindrical boilers; *Cristobal Colon* Spanish Navy, with Niclausse boilers; *Pueyrredon*, Argentine Navy, with Belleville boilers; *Giuseppe Garibaldi*, Italian Navy, with Niclausse boilers; but many improvements have been made on the original type, especially in the armament and fittings, the means of supplying ammunition to the different pieces, and the electric arrangements and production.

Exceptional Locomotive Dimensions.

THIS engine entirely transcends, in point of dimensions and power, all other types of passenger or goods locomotives hitherto placed on British metals.

The engine No. 49 and her sister engine No. 50 were designed by Mr. J. F. M'Intosh, Chief Mechanical Engineer of the Caledonian Railway, to haul the heavy Anglo-Scottish West Coast dining-car trains, weighing about 350 tons, between Carlisle and Glasgow, over the Beattock bank, which is 10 miles long, the greater portion being on a gradient of 1 in 75, and to do this without the assistance of a pilot or bank engine on a fast booked timing. They were built in the locomotive workshops of the Caledonian Railway at St. Rollox, near Glasgow.



THE NEW CALEDONIAN GIANT, NO. 49. MR. J. F. M'INTOSH'S SIX-COUPLED TEN-WHEELED EXPRESS ENGINE.

Cylinders, 21-in. in diameter, with 26-in. piston stroke. Boiler heating surface, 2,400 square feet. Steam pressure, 200 lb., with four separate safety-valves. Total weight, exclusive of tender, 72 tons.

The accompanying illustration is the reproduction of a snapshot photograph taken by a correspondent as the new engine was standing at the head of its train at the outer end of the Central Station, Glasgow.



THE NEW CUNARD LINER "CARPATHIA."

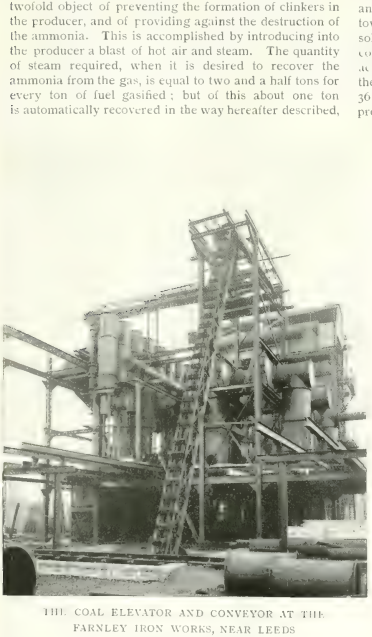
The first vessel built for the Cunard Company to accommodate exclusively second and [illegible] passengers. The details of this new departure are referred to in "Our Monthly Resume."

Power-Gas Production.

The method of producing power-gas and recovering the by-products employed by the Power-Gas Corporation, Ltd., is described in an interesting manner in a finely-printed booklet just issued by that Company.

Wherever possible, the slack to be gasified is discharged direct from the railway trucks into an elevator-boot. From this boot the slack is mechanically conveyed to the storage hoppers. The accompanying illustration shows a typical coal elevator and conveyor. From the coal-hoppers the slack is fed into the producers, where the combustible matter is converted into gas.

The producer is provided with a water-seal, and is so constructed as to allow the ash, which is the only residue, to descend into the water, from which it is easily removed without interfering in any way with the working of the producer. The process of combustion in the producer is carried out at a comparatively low temperature, with the twofold object of preventing the formation of clinkers in the producer, and of providing against the destruction of the ammonia. This is accomplished by introducing into the producer a blast of hot air and steam. The quantity of steam required, when it is desired to recover the ammonia from the gas, is equal to two and a half tons for every ton of fuel gasified; but of this about one ton is automatically recovered in the way hereafter described, and this is used over and over again. In the case of installations where it is not proposed to recover ammonia, the quantity of steam necessary is reduced to about one ton for each ton of fuel gasified.



THE COAL ELEVATOR AND CONVEYOR AT THE FARNLEY IRON WORKS, NEAR LEEDS (MOND PATENTS).

After leaving the producer the gas passes through a regenerator so arranged that part of the heat of the gas and steam entering it is transferred to the blast of air and steam on its way from the air-heating tower to the producer, the gas being consequently cooled to a corresponding extent. The gas is then delivered into a mechanical washer, a rectangular iron chamber, where it is thoroughly washed with water thrown up into a fine spray by a system of rapidly revolving dashers. By the intimate contact thus obtained with the water the temperature of the gas is further reduced, and all the dust and sooty substances are washed out of it. These are easily removed by an arrangement of lutes in the side of the washers. After the gas has thus been washed, the next step is the recovery of the ammonia contained in it, and for that purpose the gas passes through the acid-tower, this being almost completely washed out by a weak solution of sulphuric acid, with which it enters into combination, thus forming sulphate of ammonia. This acid solution of sulphate of ammonia circulates through the acid-tower again and again until it contains from 36 to 38 per cent. of sulphate of ammonia. In order to provide for the continuity of the process, fresh supplies of sulphuric acid are from time to time added, and corresponding quantities of the sulphate liquor are withdrawn and evaporated, thus yielding solid sulphate of ammonia of good quality, which finds a ready sale. The gas, having given up its ammonia, is passed through the gas-cooling tower, where it is subjected to a further cooling and cleaning by means of a downward flow of cold water. It is then ready for use, and passes direct into the mains leading to the works.

As the gas is cooled in this tower, the steam with which it was burdened becomes condensed and the water which entered the tower as cold water is delivered from it as hot water, and this is again pumped to the top of the neighbouring air-heating tower, when it serves to heat the air blast required for the producer.

Into this air-heating tower a blast of air is forced by a blower, and its contact with the descending stream of hot water results in the production of a hot-air blast saturated with vapour, which is duly carried into the regenerator and thence delivered into the producers, as already described. The water which was delivered hot into the top of the air-heating tower, after having transferred its heat to the air-blast, is drawn off sufficiently cold at the bottom, to be returned to the top of the gas-cooling tower to repeat its cycle of utility. This method of continuously employing the water in circulation as the heat carrying agent between the hot gas in one tower and the cold air in another, and the method of recovering from the hot gas, by this continuous cyclical exchange of heat, a large proportion of the steam required for the producer-blast, form distinctive features in the economy of the process.

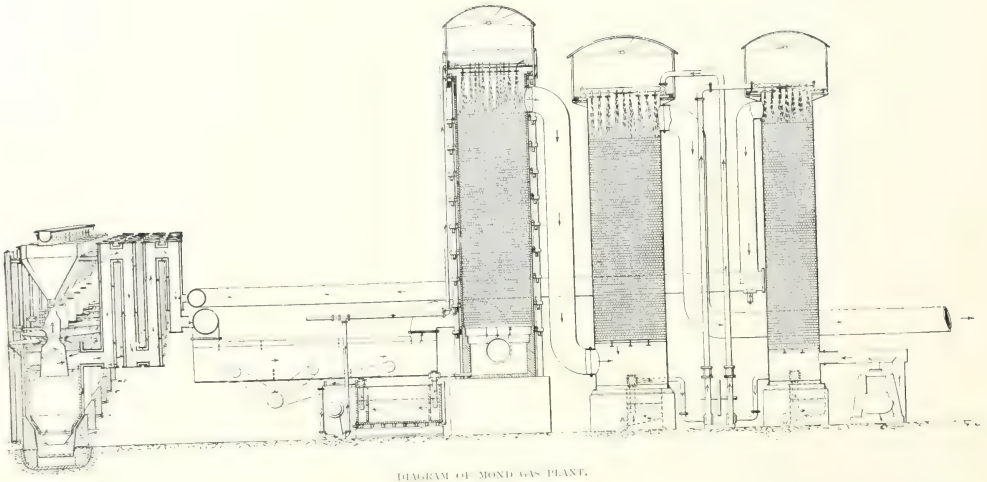


DIAGRAM OF MOND GAS PLANT.

The first apparatus for the conversion into combustible gas of bituminous small coal, commonly known as slack, and for the simultaneous recovery therefrom of sulphate of ammonia designed and patented by Dr. Ludwig Mond, F.R.S., was put into operation at Messrs. Brunner, Mond and Co.'s Works at Northwich, Cheshire, and was intended to gasify a few cwts. of slack per hour. From this relatively small beginning the gas producer plant at Northwich was step by step enlarged and extended in order to meet the ever increasing calls that were made upon it as its many advantages were recognised and appreciated, until at the present time it is capable of gasifying daily some 250 tons of slack, from each ton of which there is obtained the ammonia equivalent of about 60 lb. of sulphate of ammonia, and from 140,000 to 160,000 cubic feet of Mond gas, equal to about 37,000,000 cubic feet per day. The immense volume of gas thus generated day by day is employed in a variety of ways. It provides fuel for heating and evaporation, and is also put to various other uses suited to the special requirements of the chemical industry that is carried on, including some of the most important operations of the works, dependent for their success upon the absolute reliability and constancy of the gas. The gas is used for heating the ovens, and for cooking the workmen's dinners, and it also provides fuel for the large gas engines that are used for the generation of electricity for the works and for lighting the neighbouring township of Northwich.

The Card Index System of the W. P. Davis Machine Company.

The card index system as adopted by the W. P. Davis Machine Company, at Rochester, N.Y., has some features of interest, and the several cards here illustrated will be found worthy of examination. The cards are of uniform size, 3 in. by 5 in.—a matter of no small importance in conveniently and compactly handling and storing them.

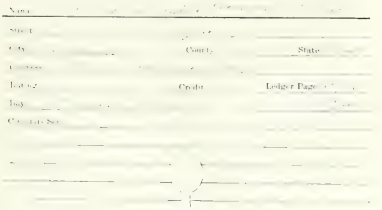


FIG. 1.

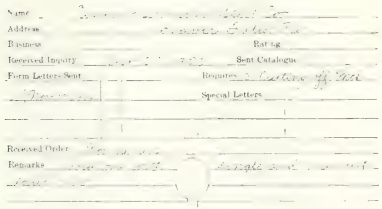


FIG. 2.

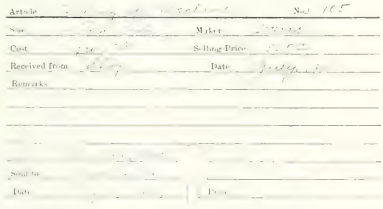


FIG. 3.

Fig. 1 is a blue card bearing the name of the Strong, Carlisle and Hammond Company, of Cleveland; blue showing that the firm deals in machine tools. The W. P. Davis Machine Company will have in the same drawers similar cards made out in a like manner, the card stock, however, being in different colours. Thus dealers in machine tools are recorded on blue cards, buyers of supplies on straw-coloured cards, buyers of engines and boilers on white cards, and so on according to the number of lines handled. The company usually employs but three colours, however. The other cards here illustrated are white.

The card seen in fig. 2 as made out to the Union Drawn Steel Company, is the result of an inquiry to the effect that the prospective purchaser required a 3-in. cutting-off machine. The history of the negotiations and the results are entered in due course on the face of the card. It shows that the original inquiry was received October 30th, 1902. A follow-up letter was despatched on November 13th, 1902, and on November 19th, an order was received for two machines. It is the office practice to make out one of these cards for every inquiry emanating from parties showing any intention of doing business, and this is of course something different from a mere desire to add to a collection of catalogues. The card allotted to the prospective customer is then dropped into an index "tickler," and will come to light again in about ten days, when a reminder will be mailed along the trail of the preceding letter. The card is then put away in the monthly file, and will appear once more at the expiration of thirty days. There must necessarily be a limit set to the letter writing which fails to bring an inquiry to the purchasing stage, and it is the custom of the company to drop the matter if not heard in reply in some manner or another at the third time of writing.

A card index is also applied to the various tools sold. Fig. 3 illustrates such a card which shows that the article sold is a cutting-off machine, and the number of the machine is 105. This is a 6-in. machine with two tools, manufactured by the W. P. Davis Machine Company. The cost of the machine is denoted by symbols, and this amount plus the profit, etc., gives the selling price as $525. This machine was received from the factory in July, 1902, and was sold to the Farrell Foundry and Machine Company, of Ansonia, Conn., on August 11th.

The handling of catalogues sent out by other manufacturers is a matter of considerable importance, and is more frequently neglected than otherwise. The firm has a very convenient filing case, and every catalogue is filed in such a manner that it can be removed without disturbing any other catalogue in the case, provided that a thoroughly [illegible] of the catalogues with

...ble, card used in connection with a complete and well-selected stock of trade literature, and this combination is employed in turn with a close price list, the man in control will be able to quote without delay on any goods his customers may require in his line of business.

Fig. 4 shows a specimen card used in such a connection. It refers to the Cleveland Twist Drill Company, of Cleveland, gives the catalogue number, etc. The card gives the articles manufactured; in this case drills, reamers, taps, milling cutters, etc.

The card illustrated in fig. 5 is indexed according to the manufactures of other firms; in this case, "upright drills." It shows that the filing case of the W. P. Davis Machine Company has various catalogues from builders of upright drills; the card giving the address of the manufacturers, and the number of the catalogue, also the page on which references to upright drills may be found. If anyone requires a drill that is not then in stock, it is possible to refer immediately to the various builders (it must be remembered that the card seen in fig. 5 shows only a part of the list), and find the catalogue by the number and the page. It thus takes but a few seconds to find the printed matter relative to the product of any builder the company may require.

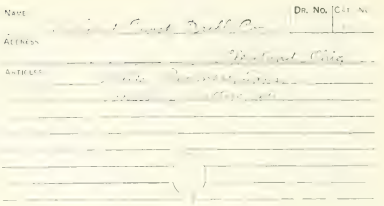


Fig. 4.



Fig. 5.

With the aid of the cards shown in figs. 4 and 5, it is easy to refer directly to any article or firm. If for any reason one cannot recall the names of manufacturers of upright drills, a reference to the subject matter, "Upright drills" will at once secure the name of the desired firm. On the other hand, a reference to the name of the manufacturer will disclose the line of goods he makes.—*The Iron Trade Review.*

Destructors and Surplus Heat.

As Mr. Segundo pointed out in Page's Magazine, some months ago, a refuse destructor must be regarded primarily as a necessary sanitary appliance and not as a money-earning machine. At the same time, in taking a review of some of the most recent destructor plants, it is obvious that the surplus heat is finding extremely important uses in many municipalities.

One of the most important undertakings of the kind in the world and a remarkable testimony to the municipal enterprise of our Belgian neighbours is the destructor-plant being erected by the Horsfall Destructor Company, Ltd., at Brussels. This comprises twenty-four cells of the "back-to-back" "top-feed" type, and is similar to the very large destructor at Hamburg, with the addition of some important improvements in detail more recently introduced. The destructor is

The Iron Value of Town Refuse, Page's ...

provided with water-tube boilers, and one of the Horsfall Company's patent centrifugal dustcatchers. It is equipped with high-class electric plant, including cranes for handling the refuse, motor fans for providing forced draught, and clinker crushing and sorting machinery. The whole of this plant will be driven by the heat developed from the refuse alone; the guaranteed capacity of the plant being 180 tons per day.

The latest contract given out by the City of Sheffield (which has already in operation a plant of another make) is for a twelve-cell "Horsfall" destructor, situated at Penmistone Road. The plant is now practically complete. It consists of twelve "Horsfall" standard cells, similar to those at Brussels, and is provided with two "Lancashire" boilers and a "Horsfall" patent dustcatcher. This destructor will burn 120 tons of refuse per day, and will generate steam for clinker utilisation and other machinery which is being put down on the site.

At Leamington a six-cell plant of similar construction to that at Sheffield has been put down at the sewage pumping station, and the heat from the destructor will be utilised for sewage pumping, etc. A four-cell plant of the same type has just been completed at Grimsby, where the heat will be utilised for electric lighting.

About two years ago the Horsfall Company completed a six-cell plant for the corporation of West Hartlepool, at Burn Road, the house being provided

on the first instance large enough to accommodate a plant of double the capacity. The company is now completing the extension, an order for which was secured in open competition. The cells are of the "back-to-back" "top-feed" type, with the company's most recent improvements; one of the most important being that air hoods for ventilating purposes are placed over the clinker doors, and these communicate with the forced draught apparatus, any smoke or fumes given off in clinkering being thus removed at once. The boiler attached to this new plant is of the Babcock and Wilcox "Marine" type, specially modified for the purpose, and is expected to give even better results than those obtained with the original cells with the ordinary type of "water-tube" boiler.

The steam for this destructor also is utilised for electric lighting, being conveyed by a large steam main to the adjoining electric light works, and there connected to an independent generating set, so that the results obtained from the refuse will be readily and correctly ascertained.

At Bradford the company are erecting at Sunbridge Road a third (twelve-cell) destructor on the site formerly occupied by an old plant of another make. This is of the "top-feed" type, with latest improvements, and is provided with two Babcock and Wilcox Marine boilers, the steam from which will be utilised in an electric-power station which is being put down on the same site, and which will serve as a branch station for tramway driving purposes.

At Norwich, where the company have in hand the duplication of a two-cell destructor erected by them some years ago for this city, the inclined roadway commonly used is dispensed with, the refuse being brought to the top of the furnace by means of an overhead crane on similar lines to the arrangement adopted at Hamburg and Brussels.

Another interesting destructor installation is that which is being carried out by the Horsfall Company at Blackpool. This is a six-cell plant, built on very similar lines to the successful new design introduced for the City of Westminster. In this type of furnace the refuse carts, instead of tipping upon the charging hopper or platform, tip their load direct into the interior of the furnace through a door large enough to permit the whole contents of the cart being shot into the furnace at once, without raking, shovelling, or trimming. By the adoption of this system, however, it will be noticed that the loads have to be tipped into the furnace at regular intervals, and to allow for the irregularity of their arrival, it is necessary to have a few spare carts which can stand until they are required. The chief advantage claimed for this system is that there are no unsightly heaps of refuse on the premises whatever, that there is no handling of the refuse, and, therefore, the cost of the labour is considerably reduced. The facilities for dealing with light and bulky refuse on this system are increased. The charging door is closed by a special arrangement of water sealed lid, which is very necessary to prevent the escape of any fumes from the cell. It should be observed that with this type of furnace the charging door can be opened, a two-ton load shot in, and the door closed again in considerably less than a minute, an immense advance upon previous arrangements.

Zurich is coming into line with the towns of the world that possess destructors, and at Taunton a four-cell plant, of which two cells are at present in use, has been recently completed, and is now in full operation. The plant is of the "back-feed" type, and is utilised for sewage pumping.

English and German Industries.

A *Times* correspondent draws attention to an interesting comparison between the present condition of English and German industries in a magazine of political economy—Professor Schmoller's *Jahrbuch*. It is asserted that during the last decade German industries have fully equalled those of England in regard to the range of their operations and their technical equipment. "Industries conducted on a small or a moderate scale, and in particular those in which the work is done at the workmen's homes, continue to exist in England in greater numbers than is generally supposed. There is also an increasing tendency to do away with specialisation among the workmen. England, however, still possesses important natural and social advantages, such as the proximity of her factories to coalfields and to the sea and a cheaper rate of interest for money advanced to manufacturers."

To counterbalance these advantages the writer advocates the establishment of a more highly developed system of deposit banking in Germany, and of a system of canals or light railways for goods traffic. Germany must be on her guard, for England is making great efforts to regain any ground she may have lost, and her system of technical education has been developed "in an admirable manner." The ground was lost, to a very large extent, by the absence of everything except rule-of-thumb knowledge among those employed in English factories. "England's efforts to drive Germany out of the markets of the world must be met in good time by improvements at home and by developing the German colonies."

This reads somewhat like the scares which have gained such wide currency in the English press.

Business and Professional.

The roof of Lostock Hall Station, on the Lancashire and Yorkshire Railway, is to be covered with patent "Eclipse" glazing by Messrs. Mellowes and Co., of Sheffield and 28, Victoria Street, London. The same firm is glazing the roofs of the Royal Naval College, East Cowes, the Electric Station for the Leek Urban District Council, and extensions at the works of Messrs. J. H. Andrew and Co., of Sheffield, and Leys, of Derby. For the new shops of the latter they are also executing the whole of the plumbing work.

THE AMERICAN WORKMAN.

FROM AN ENGLISH WORKMAN'S POINT OF VIEW.

The writer, an English workman, tells in his own way the story of his experiences in American shops, and records his impressions of American workmen.—Ed.

AS an Englishman who has spent a number of years in American shops, I find that I have considerably less admiration for America than I was disposed to feel as a youth before I went there. My respect for England, on the other hand, has considerably increased. I dislike display of patriotism, and, although I am not superior to feeling it in some ways, I seldom give any sign of it, especially before a foreigner. America, more than any other country, is offensive in this respect, and among the middle and working classes there it is to be seen at its worst. This is rather remarkable, considering what a mixture of nationalities the American people are, and how comparatively scarce are natives of several generations descent.

A WORD ABOUT EMPLOYERS.

On first acquaintance, American shops, and America generally, have a charm for almost everyone, and it depends on a man's temperament whether he falls permanently in with it, or becomes hostile. I was struck favourably just with the genial and courteous manner of employers. Next I found they were always like it with strangers. Then I found they were practically on a level with the men, and expected to be spoken to in the same familiar way, and took it quite as a matter of course if their word was distrusted, or if they were abused or threatened.

NO LOAFING.

Coming now to the men themselves, the impression at first was favourable. It was evident that in some ways they were on a higher level than the English workman, and, except that they worked harder and longer, it was not apparent in what way they could be economised. Sixty hours a week after the English fifty-four seemed very hard, although I was getting nearly double English wages. It seemed remarkable, too, that although the day was so long and made work still by dividing it into two long spells with only a more or less brief interval for dinner, that the work should be pursued diligently from the moment of starting until stopping time. The signs of hustle that I had expected were not noticeable, but even in the slowest shops there was practically no loafing. The general impulse seemed to be to turn out the work in the quickest and [illegible] I very soon found [illegible] to be left behind. [illegible] comfortably as possible, but [illegible] I [illegible] down [illegible] down and [illegible] that [illegible] [illegible] hungry he could spread quite an elaborate meal on the bench and eat as he worked. He is particular about temperature, and, in spite of the enormous variations outside, most shops are kept about the same all the year round,—rather warmer than most Englishmen like, but the American reckons to work comfortably with coat and waistcoat off when the weather is at its coldest outside. Outside workers take more pains to protect themselves, and in very severe weather stop work altogether where possible.

BUT MORE LIBERTY.

There was more liberty with regard to entering or leaving the shop at irregular times. Men would think less of being late, and if a man wished to leave early or escape overtime, he would often, instead of asking permission, merely tell the foreman he was going, or go without saying anything. Asking favours, especially of one's superior, seems to go against the American grain. The usual way of getting anything is to boldly assert that you are going to take it, or do it, and then wait and see what effect the assertion has, and be guided accordingly.

NEW IDEAS ABOUT IDEAS.

In methods of working, also, each man is allowed to follow his own devices to a great extent, anything unusual being noted with interest and without the least prejudice. There is always more readiness to adopt anything new than to stand by an old method. One noticeable thing in American shops is the impetus given to ideas, even of the most trivial nature. Things that here would be devised in the ordinary routine of work and discarded again, seem to be looked upon as we should look upon really great inventions in the shops. Possibly the American manner has something to do with this. As a nation we are boastful, but the American eclipses us completely in brag and ignorance of other countries. This latter is rather remarkable when we consider how largely the population there is made up of immigrants from Europe. I never talked with a genuine American workman who could seem to believe that any other country could come near America in civilisation or in brains. If they seem disposed to think otherwise, it is usually out of politeness. They know the defects at home, but they think European monarchies must be far worse. This idea is writ large in every issue of the popular American newspapers. It is so common there that no one thinks it brag; and one has to be on this side some time before the contrast is fully appreciated. They think that in [illegible] unobtrusive and

and a recognition of the high position of women, they are unique among the nations. There are things in America, of course, that on the surface might, at first sight, seem to justify them in some of these convictions. I had been there so long, and had this impressed on me so constantly, that I came back fearing that England really must be a long way behind America. It took some time for this feeling to wear off. England is slow, and conceals, or thinks nothing of things that America makes a fuss about.

I could never perceive that the British workman in America was superior to the native, as some people assert. In engineering the Britisher is there in great numbers, but I never thought a first-class American was second to any. As a man, the Americanised Englishman didn't strike me favourably. The Yankee himself always seemed superior, possibly because the Englishman was only an imitation.

NO CONFIDENCE.

What seemed to me one of the worst features of American shop life, and of American life generally, was the small amount of confidence between men. Each feels that the rest are his enemies, and not to be trusted. Instead of asking questions, things have to be found out. It is unwise to show ignorance on matters connected with the work. A man who happens to know something that others do not, always wishes to keep the knowledge for his own advantage. As Americans are toward other nations, so they are between themselves. It is the custom to "blow one's own trumpet," and speak disparagingly of everyone else. In the shops there is a keen love for adversely criticising one another, particularly in confidence to the foreman.

GETTING AND GIVING "NOTICE."

Another peculiarity about the American workman is that it seems unnatural to him to leave a shop without having a quarrel with the employer. Changes are more frequent there than in our own shops, and in my own experience I never saw a man leave anywhere without either an open quarrel about some trifle, or else a sudden coolness on both sides after notice was given; the man behaving as if the shop was not good enough for him, and the foreman as if he was sick of having such a man about. For this reason presumably, notice is seldom given until the last moment, and the man does practically no work after he gets it. In fact, there is sometimes a risk of his doing mischief if he has a chance. At one place I worked in for over a year, where from fifty to a hundred men and boys were employed, there were changes every week, and I believe no one was ever discharged in the ordinary way. This place, of course, was quite exceptional, but the employees there were good samples of American workmen. When the employer had not enough work to keep a man going, he would never tell him so in a straightforward manner, but find some trifle to pick a quarrel about, and the man, understanding what was meant, would throw the job up himself.

EXPRESSIONS THAT PLEASE, BUT FINALLY NAUSEATE.

One characteristic of the American workman which is noticed immediately is the peculiar style of speech. It has rather a charm at first to the English ear, and many of the expressions seem original and appropriate. Actually, however, originality is one of the things that is wanting in American speech. These expressions are used so constantly and exclusively that they become nauseating. The fact that the Americans themselves never get tired of them, or attempt any variation, might almost be considered as evidence that they can never be a really great people. The only approach to it among English workmen is the repetition of the familiar expletives that are supposed to adorn and give strength to every remark. Americanisms, however, are much wider spread and more tiresome to listen to. Not only are words constantly and needlessly used, but sentences become crystallised and spoken in one set form in ordinary conversation, perhaps scores or hundreds of times a day by each man, according to the amount of talking he does. A good deal of it is what we should call slang. Some is good English, but becomes tedious from so much repetition. Said in the popular way, a remark is instantly grasped. Said in almost the same words differently arranged, it is not so clear. No doubt this is partly due to the large proportion of immigrants who have to learn the language, and become proficient in it only as it is ordinarily spoken. But even the natives seem to delight in commonplaces and meanness.

STANDARD OF LIVING.

The American workman's standard of living is unquestionably higher than the English, and would remain so, even if he went in as much as the Englishman for beer. He eats less in quantity, and less frequently, and doesn't enjoy eating much, but there is more variety in his food. It costs about the same in England, but, no doubt, considerably more is spent on it. He dresses better, and lives in a better house. Comparatively few men care to go through the streets from work with dirty face and hands and clothes. In some cases they make an entire change night and morning in the shop, so that outside they are as well dressed as a business man. The time, however, during which they can appear like this is brief. As with work, so with relaxation. It cannot be taken in so leisurely a manner as here. Holidays have to be taken in a very sober fashion, for the custom is to have one day only at a time, and start promptly at the regular time next morning. The rule in the streets is to be orderly and conventional, and the policeman is a man to beware of. In spite of the freedom and independence which the workers there suppose they possess, I was struck when I went there, and when I returned to England, with the contrast in the possibilities of successful appeal against injustice in either country. There everything seemed to be considered in a superficial spirit. If a man had in some way got an advantage over others there seemed to be no remedy. There was complaint enough, but it didn't seem to be so seriously taken or meant as it would be here. The American can be hard and relentless, and in a quarrel he is bitter. He is extremely sociable, but with less of the underlying sweetness and good humour that pervade English life. Individually, he is as good a friend as any man, but only within a limited circle. Keep him at a distance, and he will not hesitate to take any advantage which he thinks it safe to do.

Of recent years and especially during the slack time, employment is, if anything, more difficult to obtain than here. In fact, there are times, even in large towns, when a man knows it is quite useless to look for work. This, in time, no doubt, will sober down the American spirit. In past times employment could be obtained without much difficulty, and wages, though lower actually, had a higher purchasing power. The older residents remember this, and feel that, as employees, their conditions are getting steadily harder, and less worth boasting about. They feel that they are working not so much for themselves as for their country's benefit, as for a few hundred millionaires at the top. Unlike the working people of most other countries, they do not look upon the men on top as their superiors. W. H.

IRON AND STEEL MANUFACTURE.

Remarks on the Disposal of the Blast-Furnace Slag: the Gas Mains: the Controlling Gas and Hot Air Blast Stove Equipment.

By B. H. THWAITE, C.E. (Medallist Metallurgy, Paris Exposition, 1900).

In the preceding articles the author dealt with the choice of site, the selection of ores, the most economic methods of transportation from the mine to the mouth of the furnace, and the charging of mineral and furnace equipment.—Ed.

V.

THE QUESTION OF SLAG UTILISATION.

ALONG with the increase in output capacity of modern blast-furnaces there has been an associated addition to the slag effluent, and a rapid method of removing this often unsaleable material has had to be found. It was explained in the last article that the slag is being used, from certain furnaces, in the manufacture of cement, and there is little doubt that in the near future further progress will be made in the attempts to include the slag from furnaces using the purer ores, in the process equation of Portland cement manufacture.

With slags of certain chemical constitution it has been possible to apply high-pressure steam jets to the fluid slag in such a way as to transform the fluid into wool-like fibre, and as slag-wool the material has found a saleable position, and is being used for many purposes when its heat-nonconducting properties can be utilised.

If the slag is run (as a fluid) into water, it assumes a granular physical form, and by the sudden cooling effect becomes hard, and provides an excellent agent for many structural applications, such as road or gravel path making.

The manurial value of slag from basic iron furnaces is becoming recognised by agriculturists, and this field of use is likely to be extended.

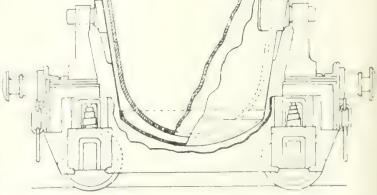


FIG. 1.

Previous articles were: The choice of site . . . selection of ores, maps and two diagrams, July; The transportation of the . . . furnace, blast and slag-wool, August; Transportation of mineral . . . coal at furnace throats, September. Charging of mineral and furnace equipment (twelve illustrations), November.

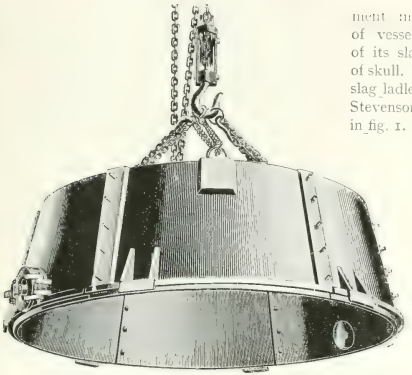


FIG. 2.

moreover, with the extension of the dynamic power-producing range of the blast-furnace, the power set free can be employed for the physical reduction to an extremely fine state of division of the slag—a refinement that is only economically possible where low-cost motive-power is available.

SLAG TRANSPORT

Where the slag is run into large ladles, the main requirement in the design is to secure a shape of vessel that will retain, on the discharge of its slag contents, the minimum proportion of skull. A characteristic section of one of these slag ladles, introduced and perfected by Messrs. Stevenson and Dewhurst, and others, is shown in fig. 1. The slag-carrying vessel is of cast iron, easily renewable, and carried by a steel plated shell or casing, the latter being equipped with trunnions mounted on a truck carriage. The tipping of the ladle, with its slag contents, is either effected by a drag chain, plus a locomotive, or by means of a steam crane.

The American typical method of slag removal can be described by reference to the illustrations

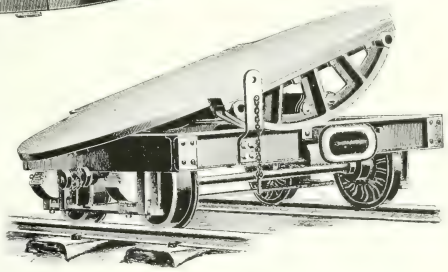


FIG. 4

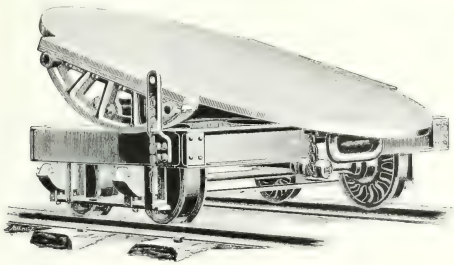


FIG. 3.

(figs. 2, 3 and 4). It will be seen that the ladles are formed of two distinctive parts. The ladle itself is a hollow frustrum of a cone—and it can be bodily lifted from its base, on which it merely rests, the base itself being mounted on rockers bearing on a railway truck. When ready for the reception of the fluid slag, the base plate is of course positioned horizontally, but when the truck has been

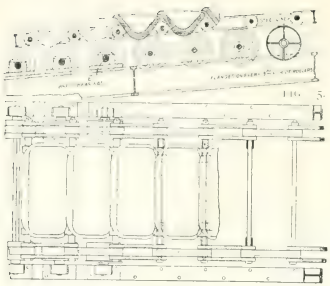


FIG. 6.

hauled to the slag tip or other position, the ladle is lifted bodily, leaving the slag content with its chilled shell of slag resting on the base plate of truck. By the mere tilting of the base plate on its rockers the slag is deposited. This arrangement is very handy, and prevents any great accumulation of clinging skull to the sides of the ladle.

There is, however, the danger, if the slag is stripped too soon, of the shell of skull collapsing with the lifting of the ladle from

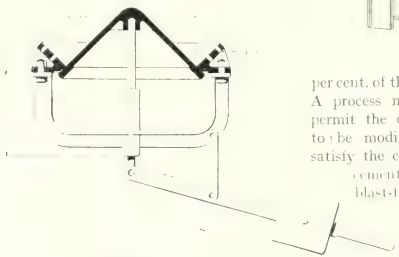


FIG. 8.

the truck; all the skull then flows over the enclosed base platform on to the floor to the great danger of the men in charge. The system is not equal in efficiency to the regular ladle form shown in fig. 1.

Mr. Hawdon, of Middlesbrough, is responsible for the travelling slag mould or trough system, also proposed for pig casting, the principle of which will be easily realised by reference to the figs. 5, 6 and 7. The slag runs into the moulds or troughs, carried by endless chains, which transfer the troughs with their slag contents into a water cooling well, in which the slag is rapidly solidified, and rendered in a fit condition for discharge, which is automatically performed, the slag contents being deposited as desired.

Part of the existing thermal waste in the process of iron manufacture is the heat stored in the fluid slag, which varies from 4·5 to 6

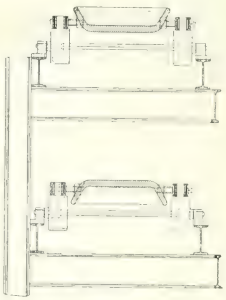


FIG. 7.

per cent. of the total heat supplied to the furnace. A process may yet be perfected which will permit the constitution of blast-furnace slag to be modified whilst in a molten state to satisfy the characteristic equation of Portland cement, and in this way the fluidity of blast-furnace slag and the heat represented by it will be utilised.

A method has recently been suggested by Mr. Brown and patented, by which some proportion of the heat of fluid slag can readily be utilised for heating air. This consists in transporting the slag ladle with its fluid slag contents into a chamber, similar to a core drying stove, into which, after being closed, air is introduced under pressure. The

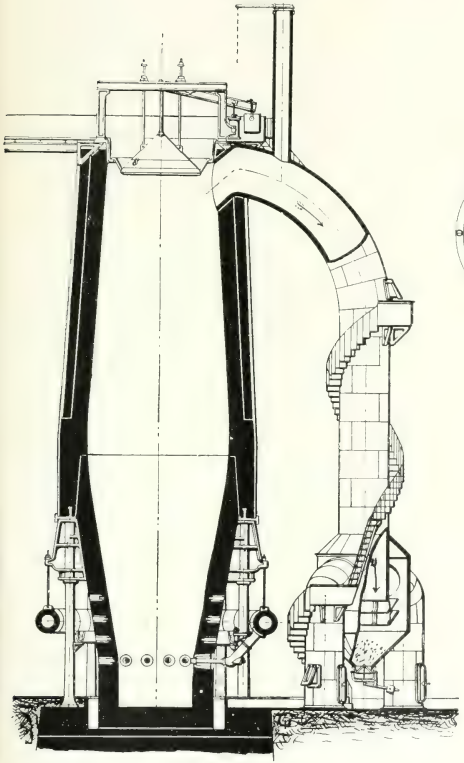


FIG. 8. SECTION OF BLAST-FURNACE TO EXHIBIT EQUAL GAS DOWNCOMER AND DUST CATCHER ARRANGEMENT.

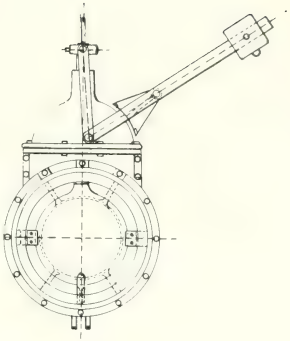


FIG. 19.

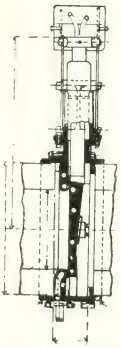


FIG. 18. WATER-COOLED COMPOUND LEVER GAS VALVES.

heat of the fluid slag is thus rapidly reduced, and is absorbed by its air environment.

THE FURNACE GAS MAINS.

The volume of the effluent gases that escape from a modern high-pressure high-output capacity blast-furnace is of almost incredible proportions. Taking a furnace having a daily iron output capacity of 570 tons, there will be in every hour of the twenty-four an effluent volume of some seven millions of cubic feet, and this volume has to be distributed to the hot blast stoves and steam boilers, that is, if the author's more direct system of power production has not been applied. It is certainly not advisable to check by unnecessary flue friction the outflow of this volume of gas, such a resistance would inevitably only throw additional work on to the blowing engines. The design of downcomer leading away the effluent from the

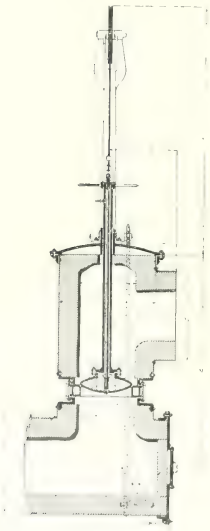


FIG. 11

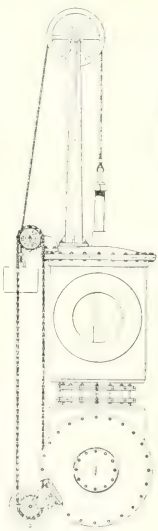


FIG. 10

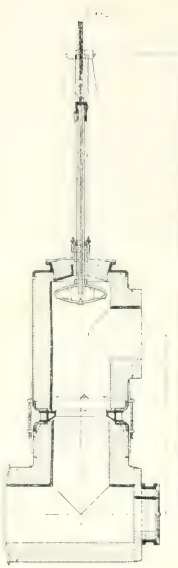


FIG. 12.

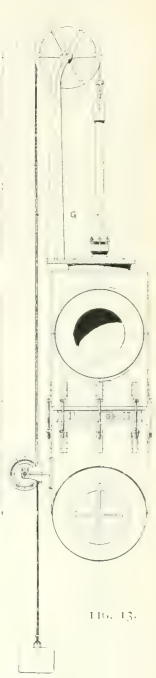


FIG. 13.

furnace, shown in fig. 8, is excellent. The gas will flow freely away from the furnace, and as freely descend the downcomer, until it reaches the *cul de sac* formed by the dust-catcher vessel at its base. This dust-catcher has an inverted cone-shaped lower terminal, and the usual automatic dust discharge bell, which opens when the dust accumulation has attained certain weight proportions. This discharge bell is shown in detail by fig. 9. The downcomer is internally lined with refractory material, and has spirally arranged around it a serviceable stairway. The

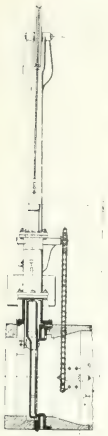


FIG. 14.

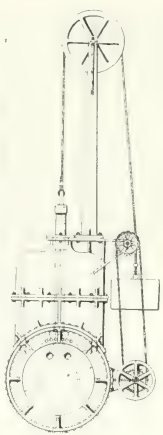


FIG. 15.

usual candle-stick projects from the top limb of the downcomer.

The direction of the flow of the gases is reversed in the dust-catcher vessel. The heavier particles of dust brought down the downcomer acquire the velocity of the gases, and in a vertical direction, the effect of gravity plus velocity due to the flow of the gases projects the heavier particles against the bottom of the dust-catcher, where they partially accumulate as described.

As the sensible heat of the gases represents a considerable percentage of the thermal assets in the fuel fed into the furnace, it is obviously advisable, at least for stove and boiler firing applications, to prevent the loss of this sensible heat by avoidable radiation.

A generous proportion of cross-sectional area should always be provided for the gas connections between furnace and stoves and steam boilers.

If properly lined with firebrick there should be very little loss of sensible heat due to the reduced velocity of the gases. The frictional effect would be lessened, because we know that the ratio of the circumferential dimension falls with increase of cross-sectional area, and the frictional effect is correspondingly reduced; besides ample capacity of flue area will induce the deposition of the heavier particles of dust from the gases.

The influence of the high pressures of modern American practice in increasing the proportion of dust in the effluent gases—and more especially when the ores are physically small—has been very great. An American authority gives the figure of ten per cent. of the weight of the mineral actually fed into the furnace as a representative proportion of the mineral carried away as dust in suspension along with the effluent gases.

One definite statement of the measure of this loss in a furnace with a daily output of 600 tons. shows that the value of the loss per annum cannot be less than £8,525.

The importance of recovering this suspended mineral from the gas will be realised, and the system by which such a recovery is possible will provide the subject for a special article in the future.

CONTROLLING GAS AND AIR VALVES.

Although the desirability of making the air and gas mains of ample cross-sectional area is

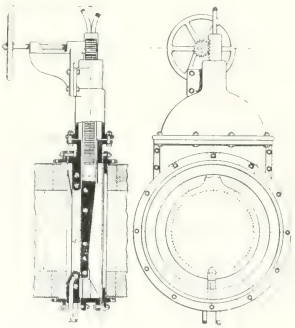


FIG. 16.

FIG. 17.

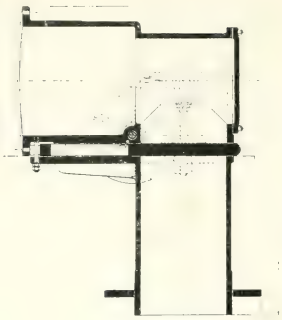


FIG. 20.

Valves exposed to very high temperatures should be water-cooled, and to facilitate the action of the valve, counter-balancing arrangements can be provided; the shell should be

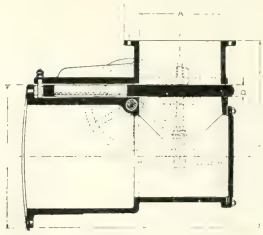


FIG. 22.

demonstrated, this does not necessarily imply that the gas and air supply controlling valves

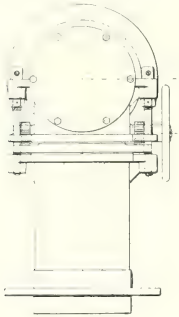


FIG. 21.

need be any larger than that which will permit the air or gas to flow in the volume required The enlarged flues and mains can be connected up to the valves, of the usual dimensions. The types of valves employed in modern American practice are shown in the various [illegible] to 23.

internally lined with firebrick blocks, as shown in figs. 10 to 13.

For ordinary temperatures, a steel mushroom valve satisfies all requirements; its dilation, due to expansion, is uniform; it adjusts itself to its seat satisfactorily, resisting high temperatures and oxidation effects very well.

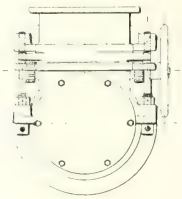


FIG. 23.

The rack actuating slide valve shown in figs. 16 and 17 is reliable. This kind of valve maintains its efficiency for a long time, if reasonable care is given to it. The compound lever valve actuating arrangement shown in figs. 18 and 19, page 537, can be recommended, where rapidity of movement in closing and

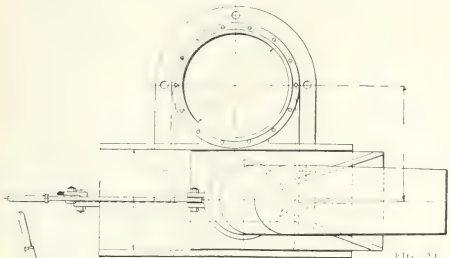


FIG. 24.

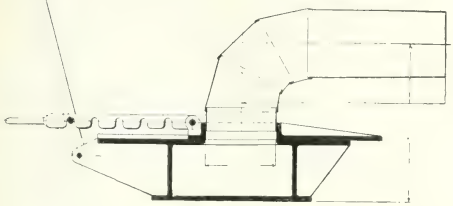


FIG. 25.

Although the valve designs illustrated are chiefly typical of American practice, they represent arrangements that combine all the elements to secure sustained efficiency.*

Generally in the construction of the gas, and even the air mains, insufficient constructional and maintenance care is exercised to secure the minimum functional effects and prevention of air and gas leakage. It is suggested that a simple form of enclosed or guarded pressure gauge be fixed at different points along the air and gas mains to permit the ready determination of loss of energy by the two causes named—friction or leakage.

* The author is indebted to the Philadelphia Engineering Company, U.S., for several of the valve designs.

opening of valve is desired. It will be seen that the cooling water for the valve, shown in figs. 10 to 19, is introduced through coils of pipe, partly cast in the valve structure. Another arrangement of cooling is shown in figs. 14 and 15. A simple form of gas inlet valve, for stove or boilers, is shown in two modifications (figs. 20 to 23). The slide rack valve is actuated from an externally placed worm wheel arrangement.

The chimney or waste gas stove valve arrangement, illustrated by figs. 24 and 25, is very handy — its action is sufficiently evident.

The hot-air main connection to blast-furnace tuyere, shown in fig. 26, is designed to provide for the dilation due to varying temperatures, in whatever direction such expansion proceeds.

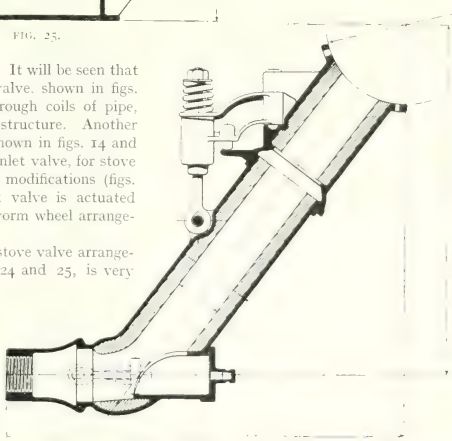
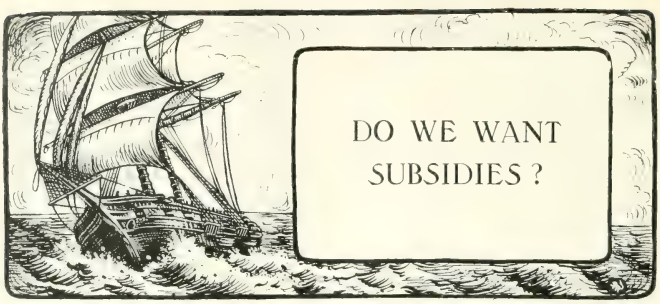


FIG. 26.



DO WE WANT SUBSIDIES?

BY

BENJAMIN TAYLOR.

The Author discusses the present position of British shipping, with special reference to subsidies, and criticises some of the conclusions arrived at by the Cecil Committee.—Ed.

THE effect of foreign bounties upon British trade continues an engrossing subject of discussion, and there is little room for doubt that if the bounty-giving nations had not agreed, on terms, to abolish the bounties on the exports of sugar, this country would decide to countervail them. There is, further, little doubt that the country would do a great deal to avert any real attack upon our maritime supremacy. The Morgan Combine has taught even the man in the street to think more about our great national industry, though it had nothing to do with the origination of the inquiry into ship subsidies. In the definition of the term "subsidy," Mr. Cecil's Committee were not very happy. They say that "bounties, subsidies, and subventions are all terms used for payments made for some kind of value received, irrespective of the policy which may be involved." But, whatever may be the literal meanings of the three terms, they are not in practice applied to the same thing. A "bounty" may be on the production or export of sugar; a "subsidy" on the size or speed or navigation of a ship; a "subvention" for the conveyance of mails, or the provision of appliances and conditions for special purposes. A shipping subvention is a payment for some service actually rendered, say, for postal carriage, or the maintenance of the vessel to a standard necessary for Admiralty, though not for mercantile, employment. A [illegible] payment to a shipowner merely because [illegible] consideration in the two terms.

BRITISH MAIL SUBVENTIONS.

[illegible] and that "British policy has usually been to subsidise ships for postal or Admiralty [illegible] to exclude all consideration of trade interests, but in the British case, rapid postal communication has mainly, and in fact necessarily, followed the lines of great commercial traffic." This suggests the idea that postal and Admiralty subsidies have actually assisted in, or stimulated, the development of this great commercial traffic. The provision of regular payment and rapid postal communication has, no doubt, stimulated commerce everywhere, but the mail subventions are a consequence, not a cause, of postal expansion, and mail subventions are not always or generally in themselves profitable. That may be fairly inferred from the reluctance of shipowners, even in the neediest times, to compete for them. The Committee also stated that one of the witnesses examined expressed the opinion that "full postal value" is not in all cases obtained for mail subventions. But quite recently Sir Thomas Sutherland told his shareholders that the P. and O. Company are now receiving only half the mail subvention they did thirty years ago, though they are doing four times the mail work. The truth is that mail subventions are contract payments for cargo carried, and whether large or small, are probably in the aggregate a great deal smaller than if the Post Office had to negotiate freight for every mail bag sent away. The rate, like ocean freight generally, is a mere matter of bargain.

What is to be noted about British mail subventions is this, that they do not sustain or promote the development of British shipping. The amount of sea carriage done by the mail steamers is but a small fraction of the sea traffic of the world. As to mail steamers the Committee put it: "In granting British subsidies, the objects mainly held in view are speed and regularity of postal service, and Admiralty requirements for the call of steamers in time of war or need. Trade interests are not considered, except that mail services follow the lines of great commercial traffic. The only deviation from this

policy occurs in the case of the £4,000 annual subsidy for the West India service to Jamaica, which is an outcome of the recommendations of the West India Royal Commission of 1896–7, and has been established under contract with Messrs. Elder, Dempster and Co., of Liverpool, to encourage the fruit trade of these islands."

COMPARISON WITH FOREIGN NATIONS—GERMANY.

If we turn to foreign Governments we find how different their subsidies are. The North German Lloyd, the Hamburg-American, the German East Africa, and one or two smaller companies in Germany, get subventions for the conveyance of mails on the same principle as our own. These are not subsidies to shipping in the proper sense of the term. But the German Government grant bounties in indirect forms, viz., in exemption from payment of Customs duties on all sea-going craft, and on the material used in their construction, repair, maintenance, and equipment; and in preferential railway rates on the same over the State railways, and also in preferential railway rates on the cargo brought into and taken out of the ports by German vessels. These railway rates are made particularly preferential in the case of goods from inland Germany for the Levant and East Africa lines of steamers. The differences in favour of German combined land and sea through-rates of freight as against the British, are striking. The cost per ton of sending iron rails from Birmingham to Liverpool, which is (ninety-seven miles, or) 156 kilometres, is 8s. 4d.; the cost per ton of sending iron rails from Oldenburg to Hamburg, which is 160 kilometres, is 3s. 4d. on the East African tariff, and 3s. 2d. on the Levant tariff. The cost of the carriage of machinery packed for export from Leicester to Glasgow (313 miles, or) 504 kilometres, is 36s. 4d. a ton; from Wronke, East Prussia, to Hamburg, also 504 kilometres, it is 1s. 10d. a ton on the East African tariff, and 7s. 10d. a ton on the Levant tariff. The carriage of hardware from Birmingham to London (111 miles, or) 179 kilometres, is 21s. 8d. a ton; from Flensburg, Schleswig-Holstein, to Hamburg, also 179 kilometres, it is 4s. 2d. a ton on the East African tariff, and varies according to the class of hardware between 4s. 1d. and 4s. 9d. on the Levant tariff. The rate for export bales of cotton from Manchester to Bristol (175 miles, or) 282 kilometres, is 22s. 4d. a ton; from Berlin to Hamburg, 279 kilometres, it is 8s. 7d. on the East African tariff, and 4s. 1d. on the Levant tariff. Thus is German shipping subsidised by the State railways.

FRANCE.

The amount of French postal subsidies voted in the Budget of 1901 was £1,067,271, but to these must be added bounties for construction or shipbuilding to the extent of £232,000, and annual bounties for navigation, paid per mile run, amounting to £488,000; the grand total being £1,787,271. There are additions required even to this figure, in respect of bounties on machinery and repair of machinery; and by a law of 1902, a French shipowner has the further right to *compensation d'armement*, or outfit bounty, paid to a foreign-built steamer of iron or steel, for each day it is commissioned, if its tonnage exceeds one hundred tons gross, and if it is engaged in the ocean or international coasting trade. The total amount of new tonnage entitled to bounties is limited to 500,000 gross tons for steamers (of which 200,000 tons may be of foreign construction, but under the French flag), and 100,000 tons of sailing vessels. These subsidies are quite out of proportion to the services rendered, and French trade has not advanced with the increase of the subsidies, while French shipowners, especially sailing-ship owners, have benefited at the expense of their country. Under the old law of 1893, which granted a navigation bounty of 1 franc 70 cent. per gross ton per 1,000 miles run to sailing vessels, as against 1 franc 10 cent. to steamers, not only was an excessive output of sailing vessels encouraged to the detriment of steamers, but it was found profitable to construct sailing ships of 4,000 tons and over in order to earn the highly remunerative bounties. Owing, again, to the method of French measurement of tonnage, if a British vessel is transferred to the French flag, its gross tonnage is at once increased, and its net tonnage diminished, and as bounties for sailing mileage are paid on the gross tonnage, while foreign port and light dues (except in the Suez Canal) are charged on the net, the change is an indirect profit to its owner. The *surtaxe d'entrepot* is a double duty charged on all goods destined for France and transhipped in a non-French port on their way. Thus, a steamer with 5,000 tons of cargo on board coming home to London, and carrying 100 tons for France, could only tranship this French cargo into a coasting steamer sailing from London to France by incurring a penalty of double duty on every ton.

RUSSIA.

Russian subsidies are paid for the transport of troops, ammunition, and passengers, amounting in 1899 to £318,061; and for postal services, amounting in the same year to £46,695; total, £364,756. A special subsidy was in 1901 granted to a steamship to inaugurate trade with the Persian Gulf. The largest subsidies are granted, for the transport of troops, ammunition, and passengers, to the Russian Volunteer Fleet (600,000 roubles, together with 600,000 roubles more as repayment of Suez Canal dues—£127,500), and to the Black Sea Navigation Company (650,000 roubles, with 200,000 roubles more for Suez Canal dues, £90,312).

AUSTRIA.

Austria pays two kinds of subsidies. The Austrian-Lloyd Company receives £242,000 a year (together with £5,000 a year for parcel post) mainly for postal service but conditions are attached, that the company may not alter its rates without consent of the Minister of Commerce, and this, we believe, has been found very mischievous. A further subsidy is also given by the repayment of certain dues, such as those of the Suez Canal. The second kind of subsidy is trading and trip bounty paid to the mercantile marine since 1894, and amounting in 1899 altogether to £84,250. This

brings the total of Austrian subsidies annually to £318,988. Austria has a trading bounty of 6 florins per ton for iron or steel steamers, 4.50 florins for iron or steel sailing ships, and 3 florins for wooden or composite sailing ships, during the first year after the ship's launch, these amounts decreasing by 5 per cent. yearly, and ceasing altogether after fifteen years. These trading bounties are increased by 10 per cent. for ships built in national dockyards, and 25 per cent. if constructed to the extent of at least one-half of home-produced materials. The ships must be owned in respect of two-thirds by Austrian subjects, and the bounties are not paid while the ship is laid up. The trip bounty has been paid at the rate of five kreutzers per ton net for every hundred nautical miles outside of coasting. In Hungary the total annual subsidies are £80,755, partly for postal services.

HOLLAND.

In Holland subsidies are only paid for value received, as an indemnity for the regular transport of mails. They are not paid for construction or navigation.

SWEDEN AND NORWAY, ETC.

Swedish subsidies are granted purely for the conveyance of mails, and for the maintenance of steamer communications "in the interest of navigation and trade." The total amount under both kinds of subsidy is merely £20,591 a year. An indirect form of assistance consists in the Government refunding the duty on all imported materials actually utilised in the construction of vessels, whether for Swedish or foreign account. In Norway the total amount of subsidies is £28,252, of which £10,754 is purely postal, and £17,498 "for facilitating steamer communications." Denmark pays £29,669 a year in subsidies, which are declared to be no more than a fair remuneration for the actual service rendered. The Danish State railways accord for transport in any direction by land or sea a progressive reduction of the railway rate the longer the distance to be traversed.

There are only small subsidies in Belgium, paid to the North German Lloyd and German Australian Companies for calling at Antwerp. Shipbuilding materials are admitted entirely free of duty.

JAPAN.

In Japan the system of subsidising has developed immensely since 1897. The principal amounts authorised in 1898 for particular services included £272,950 to the Nippon Yusen Kaisha for the European Line, £66,765 to the same company for the Seattle Line, and £103,500 to the Toyo Kisen Kaisha for the San Francisco Line. In addition, annual sums are paid for construction and navigation bounties. In 1899 the total amount of subsidies was estimated at £584,666. In 1900 further sums of £59,208 for certain lines to North China and Korea, and £29,793 for the Yangtse line, were provided. In 1901 a subsidy of £53,000 was authorised for the Australian line, and £18,250 for the Bombay Line, and there are other large subsidies [illegible] per [illegible] mile [illegible] Japan to London and back by the Japanese Government is stated to be about £10,000.

THE UNITED STATES.

The United States pay only postal subsidies—as yet—but in practice these postal subsidies are calculated on rates much higher than usual; in one case the rate is as much as $4 a mile. The British rates on the New York mail service are 3s. a lb. for letters and post-cards up to a certain limited weight, and 2s. a lb. for all above that weight. Mail matter other than letters and post-cards is carried at 3d. a lb. The United States Government, on the other hand, pays three rates. It first pays £3,000 per voyage to the American Line, as being the United States Government special mail service, without regard to the weights carried. Then, to American-owned ships it pays $1 60 cents (6s. 8d.) a lb. for letters and postcards, and 8 cents (4d.) a lb. for other articles, while it only pays vessels other than American, carrying mails, 1s. 10d. a lb. for letters and post-cards, and 4½ cents a lb. for other articles.

The United States Subsidy Bill, as amended by the Senate last Congress, and sent to the House of Representatives, proposed to grant large subsidies to ships on the United States Register; it aimed at encouraging the construction of merchant ships which could be used as cruisers, and promoted the formation of crews consisting of American citizens. The first part of the Bill provided for a subsidy ranging from 1$\frac{1}{10}$ cents to 2$\frac{7}{10}$ cents per gross ton per hundred nautical miles traversed, according to the size and steaming power of the vessels concerned, on all vessels carrying mails between ports of the United States and such ports in foreign countries, Canada excepted, as in the judgment of the Postmaster-General, having regard to the national defence, would "best subserve and promote the postal, commercial, and maritime interests of the United States." Not more than five million dollars (£1,000,000) was proposed to be paid annually until 1907, and not more than eight million dollars (£1,600,000) was to be paid after that date, persons entitled to the subsidy submitting, if necessary, to a *pro rata* deduction. The second part of the Bill provided for a subsidy of 1 cent per gross registered ton on all vessels exceeding 1,000 tons for each hundred nautical miles sailed, up to sixteen entries at ports of the United States during the year. Stipulations were added as to the length of the voyage between a United States port and a foreign port, as to the portion of the crew who must be United States citizens, and as to speed. The third part of the Bill provided for a subsidy of $2 per ton per annum to vessels engaged in United States deep-sea fisheries, so long as one-third of the crew are United States citizens, with a payment of $1 per month to the crews of such vessels for three months of the year, provided they are United States citizens. This or some similar Bill will probably be introduced to the new Congress.

REFORMS NEEDED AT HOME.

The Coal Committee do not think that an Admiralty [illegible] to [illegible] vessels of any use merely as a

retaining fee in time of war, and are of opinion that no subsidy should be paid on that ground. The possibility of commandeering and subsequent payment of fair value, they say, is well known, and there is reason to suppose that on an emergency, vessels required by the Government would be freely offered without any retaining fee; but in time of peace an Admiralty subsidy to specific vessels ought to confer the right on the Government to prevent their sale or hire into foreign control. The Committee also are "strongly of opinion that no British subsidy should be granted, except on condition that the whole or partial sale or hire of any ship, which is, or has been, in receipt of the subsidy, cannot take place without permission of the British Government. There is no objection to the Government exercising their control so as to give themselves a right of pre-emption." The Committee are further of opinion that it is "desirable "that the majority of the boards of directors of all companies owning subsidised ships should be composed of British subjects.

It is more than desirable; it is essential. But we need to go a good deal further than that. It is necessary to harmonise the joint-stock company laws with the merchant shipping laws. If it is not legal for an individual foreigner to be the registered owner of a British vessel, it must be also made illegal for a joint-stock company to be the registered owner of a British vessel unless the shares are held and the management controlled by *bonâ fide* British subjects—not figure-heads.

Although the Select Committee are of opinion that British shipping creditably holds its own, notwithstanding that foreign shipping increases in proportion more rapidly, because it starts from a lower figure, yet they utter a note of warning: "We have been foremost at sea with the finest mercantile marine in the world; we are now meeting with severer competition than we have ever experienced; and our efforts must, therefore, be proportionately greater if we are to maintain our supremacy."

HOW FOREIGN SUBSIDIES AFFECT BRITISH TRADE.

The respects in which foreign subsidies seem to have affected British trade are chiefly three. The first is on orders placed by our Colonial or other merchants with foreign manufacturers in preference to British manufacturers in consequence of cheaper rates of freight, or greater convenience or regularity of shipment, from the Continent, partly caused by subsidies. The second is in the transfer of ordinary merchant vessels to foreign ownership. The third is in diverting trade to foreign sailing ships, especially as to France.

ORDERS PLACED ABROAD.

Evidence has shown that orders have been placed with foreign manufacturers in preference to British manufacturers, in consequence of cheaper foreign rates of freight, or greater convenience or regularity of foreign shipment. The Natal Government called attention to this matter. Sir William Ward, British Consul-General at Hamburg, says he is told that British merchants trading with the Levant and East Africa frequently find themselves compelled, in the interests of their customers in the Levant and East Africa, to place orders for them with German manufacturers, which would be executed in the United Kingdom, but for the impossibility of the British manufacturer competing with the low prices due to the largely reduced rates of foreign freight to those countries. Mr. Elijah Helm, representing the Manchester Chamber of Commerce, has stated that the rates of freight from Genoa to the River Plate are so much lower than from Liverpool, that the difference is sometimes sufficient to induce Manchester merchants to purchase goods on the Continent, especially in Italy and Switzerland, rather than in this country, for shipment to the River Plate ports. The New York rate for cotton goods, through the Suez Canal to Shanghai, a distance of 13,717 miles, was 27s. 6d. per ton of 40 cubic feet. The Liverpool rate to Shanghai, a distance of 10,669 miles, was 50s., for lightly pressed bales. The difference in favour of the American rate is equivalent to 4d. on a piece of cloth costing 8s. 10½d., which is 3·7 per cent. of the total value of the cloth, and this is the measure of advantage derived from the lower freight alone, which the American cotton manufacturer has in the China markets in comparison with his British competitor.

TRANSFER TO FOREIGN OWNERSHIP.

British trade has, no doubt, been affected by the transfer of ordinary merchant vessels to foreign ownership. Note some of the transfers. The old Inman Line was sold out and out to the Americans. The East India Steamship Company, Limited, consisting of eleven ships, with a gross tonnage of 13,559 tons, was sold to a German firm. In the beginning of 1900 the Scottish Oriental Line, with a tonnage of 57,600 tons, was sold to the North German Lloyd. In 1901 the British Atlas Line, of seven vessels, 8,000 tons, plying from New York to the West Indies, was transferred to the Hamburg-American Line. The Holt Line, running from Singapore, was sold in 1901 to the North German Lloyd. The Leyland Line, between Liverpool and Boston, numbering forty-four steamships, with a gross tonnage of 277,379 tons, still flies the British flag, but the American interest in it was that of Mr. J. Pierpont Morgan before the Combine. The tonnage of sailing vessels transferred from the British to foreign flags in the last ten years has also increased. Some of these sales were made to get the benefit of foreign subsidies; some were to get particular trade advantages; others to be rid of Board of Trade regulations; others merely because a good price was offered, and the ships are old. "If" (say the Subsidies Committee) "American railway management unites with steamship management, a very influential undertaking may perhaps be formed, but too many interests are often involved to make such combinations quite as powerful as might be supposed. It remains, however, quite certain that the transfer of British ships to foreign flags, whether owing to foreign subsidies or

otherwise, may cause serious results. One is that the purchasers, if backed by their governments, can develop new trades in which the British shipowner, without such assistance cannot engage. Another is the substitution of foreign officers and crews for the British crew."

TRADE DIVERTED TO FOREIGN SAILING SHIPS.

The third manner in which foreign subsidies affect British trade is in diverting trade to foreign sailing ships. This applies to the case of France, whose sailing ship tonnage has increased by 45 per cent. since 1891. French sailing ships continually take lower rates than British, and by means of their subsidies are enabled to earn a good dividend. Notwithstanding these bounties, the mercantile marine of France does not in any way commensurately respond by expansion. The net tonnage of the French mercantile marine in 1889 was 932,735 tons, of which 440,051 tons represented sailing vessels; in 1899 the total net tonnage was 957,755, including 450,635 tons of sailing vessels. One would conclude, therefore, that these shipping bounties will in time be discarded by France, like the sugar bounties, as a loss to the Exchequer, without any material benefit to the national shipping. But, on the other hand, if these bounties should be increased it may be both just and desirable to counteract them in some way, not as special Protection of the British shipowner, but as a measure of protection against Protection.

COMMITTEE'S CONCLUSIONS CRITICISED.

In this connection the writer does not agree with the following remark in the Committee's report: "In the evidence the opinion has been freely expressed that sailing vessels, apart from questions of sentiment, are quite out of date; that their disappearance may be viewed with equanimity; that even if sailing ships are not useless, subsidising them against steamers would be very much the same policy as if our ancestors had subsidised mail coaches to save them from extinction in competition with railways." As a matter of fact, mail coaches have not been extinguished by the railways, but are still run by the Post Office for the conveyance of mails, even through districts supplied by railways. But the sailing ship never will be "out of date," and there never will be any opportunity in our time of viewing its disappearance with or without "perfect equanimity." The sailing ship is the great reserve force of a maritime country. It is an invaluable economic factor, because it is something more than a carrier; it is a movable warehouse, in which it is often more profitable to store a large portion of the world's goods than in warehouses at home or abroad.

The Committee declared among their conclusions, "That a general system of subsidies other than for services rendered is costly and inexpedient." A general system of subsidies in this country is certainly not practicable, and would be destructive of the effort and resourcefulness which made our maritime greatness. But it is not necessary to subsidise our shipping in order to countervail the subsidies of other countries, whose vessels enter our ports. If it is possible to countervail sugar bounties, it should also be possible, should the need arise, to countervail shipping bounties.

A good deal is to be done for British shipping without going so far as that. In the first place, there is the abolition of the Light Dues, which shipowners have long pleaded for, and which the Select Committee have recommended. This will be a just and proper relief, but it will not be confined to British shipping, since foreign vessels entering our ports also have to pay these dues. In the next place, Board of Trade regulations should be enforced against foreign ships, equally with British ships. Either the limitations of the Plimsoll load-line should be approved and adopted by all the maritime nations, or relaxed in the case of our own ships. Our shipowners do not object to a safety limit, but they object to a limit being fixed for them alone, in such a manner as to handicap their ships against foreigners. The Merchant Shipping Laws need revision and reform for the removal of the oppressive inequalities under which British shipping has been too long placed. Shipping is not only a commercial industry of the highest importance in itself, but it is the industry upon which practically all our other industries depend. It requires and demands, therefore, all the sympathetic assistance that the legislation of a Free Trade country can afford. The greatest burden British shipping has to bear is not created by foreign subsidies, but by British legislation.

This brings us to another point. The Cecil Committee recommend: "That no British subsidy should be granted, except on condition that the whole or partial sale or hire of any ship in receipt of the subsidy cannot take place without permission of the Government." That is all very well, but in another paragraph they express the opinion: "That the subsidies given by foreign governments to selected lines or owners tend to restrict free competition, and so to facilitate the establishment of federations and shipping rings, and, therefore, that no subsidy should be granted without Government control over maximum rates of freight, and over this combination of subsidised with unsubsidised owners to restrict competition." We are not going to discuss shipping "conferences" just now, as the subject is too wide for adequate consideration in a passing paragraph, but merely remark that if these combinations have their abuses they also have their uses. But as to this recommendation of the Committee—would any respectable shipping company accept Admiralty or postal subventions if these are to be conditioned, as the Committee propose, by Government control over rates of freight, and over combination of subsidised with unsubsidised owners to restrict competition? Sir Thomas Sutherland lately told the shareholders of the P. and O. Company that such conditions in the case of mail contracts are impracticable. "We must," he says, "in all our mail contracts have complete freedom in respect of the management of our business, consistent with the carrying out of our contracts; or if not, then the Government should become our partner and guarantee

a minimum dividend to our shareholders." But in the case of Admiralty subventions, it may be noticed that the Committee on Mercantile Cruisers recently suggested that the Admiralty should become one-half registered owners to prevent transfer to foreigners. In such cases the management and profits would be left wholly to the other shareholders ; but what of losses ? There is no reasonable probability of the Admiralty sharing in these, so why should the Government, in any of its departments, have any voice in the fixing of freight ? This is purely a question of management. What harm Government interference can do in such matters both the Austrian Lloyds and the French Messageries Maritimes could tell.

The Cecil Committee are directly against the granting of subsidies to shipping for other than payment for services actually rendered. The only exceptions they admit for consideration are special cases where, for Imperial reasons, it is desirable to establish fast direct communication between parts of the Empire by British vessels, in avenues in which there is not, to begin with, trade enough to make the service remunerative. The Committee express the opinion that a special case exists for establishing direct British Imperial communication with East Africa through the Suez Canal by ships of up-to-date speed and accommodation on Imperial subsidy. The German East Africa Company has a subsidy of £67,000 per annum from the German Government.

In this connection it may be mentioned that at the recent Conference between the Secretary of State for the Colonies (Mr. Chamberlain) and the Prime Ministers of the self-governing Colonies, the subjects of shipping rings and of preferential rates of freight by British lines to foreign goods were discussed ; as also the effects on British trade and shipping of the subsidies granted to shipping by foreign Governments. And the following resolution was passed by that Conference : " That it is desirable that, in view of the great extension of foreign subsidies to shipping, the position of the mail services between different parts of the Empire should be reviewed by the respective Governments. In all new contracts provision should be inserted to prevent excessive freight charges, or any preference in favour of foreigners, and to ensure that such of the steamers as may be suitable shall be at the service of His Majesty's Government in war time as cruisers and transports." This is embodied in the new agreement with the Cunard Company.

WANTED—RECIPROCAL ADVANTAGES.

The Colonial Premiers also passed the following resolution, which may give American statesmen something to think of : " That it is desirable that the attention of the Governments of the Colonies and the United Kingdom should be called to the present state of the Navigation Laws in the Empire, and in other countries, and to the advisability of refusing the privileges of coastwise trade, including trade between the Mother Country and its Colonies and Possessions, and between one Colony or Possession and another, to countries in which the corresponding trade is confined to ships of their own nationality ; and also to the laws affecting shipping, with a view of seeing whether any such steps should be taken to promote Imperial trade in British vessels." Of course, this resolution is not legislation, but there is undoubtedly a feeling in many quarters that if a voyage from Boston to San Francisco is a coasting voyage in the meaning of the American laws and reserved to American vessels, a voyage from Calcutta to London may be fairly regarded as a coasting voyage in the British Empire, to be reserved for British vessels. It is a matter affecting the maritime interests of the whole British Empire. All our home coasting trade, and all the trade between the different members of the Empire, and between them and foreign countries, is open to the ships of all nations. On the other hand, all the coasting trade down both shores of the North American Republic is strictly reserved to American-owned ships under the register of the United States. An American vessel can carry cargo from Vancouver to London, but a British vessel cannot carry cargo from San Francisco to New York, or even to Honolulu. Russian vessels can trade between Glasgow and Hong-Kong, if they like, but a British vessel cannot trade between St. Petersburg and Odessa, or even between St. Petersburg and Vladivostok. French vessels can run as they please between London and Malta, but British vessels are not allowed to trade between Marseilles and Algiers. These and other restrictions of their own coasting trade to their own vessels by foreign countries are really extreme forms of subsidy. And the Select Committee proposed that : " Means should be taken to obtain the removal of foreign laws and regulations which exclude British shipowners from the trades appropriated by various foreign Powers to their own shipping as coasting trade ; and, if need be, regulations for the admission of foreign vessels to the British and Colonial trade of this Empire should be used with the object of securing reciprocal advantages for British shipowners abroad."

This proposal opens up a wide field. In the first place, we could not do anything of the kind unless the Colonies legislated and acted entirely in unison with us ; and it probably would not pay them to do so. In the second place, the restriction of British coasting and Imperial trade to British vessels would be Protection of British shipping, and that is not only opposed to the national fiscal policy, but it proved highly detrimental to our maritime interests under the old Navigation Laws. In the third place, it might provoke retaliation by foreign countries, though it is difficult to see what more they can do than reserve their own coasting trade—which many of them do already. In the fourth place, it would give a stimulus to foreign shipping in ocean-carrying between foreign countries, and handicap British shipping in the international competition. But, while we need not debar foreigners from our coasting trade, we can demand reciprocal advantages, and insist that all vessels engaging in trade within the British Empire shall be subject to the same rules and regulations as British shipping.

LOCOMOTIVE ENGINEERING NOTES.

THE FIRST PRIZE.

WHAT may fairly be deemed the first prize in British locomotive engineering appointments has now been awarded. Probably no one will be found to dispute the view that this distinction may rightly be regarded to attach to the locomotive engineership—or chief mechanical engineership, if that form of expression be preferred—of the richest and most important railway in Great Britain—the London and North-Western. By the retirement, recently announced in these columns, of Mr. F. W. Webb, who had held for so many years that arduous and responsible position, a vacancy was created which has been filled by the appointment of Mr. George Whale, who long had been virtually Mr. Webb's second in command. It may be permitted to the writer of these notes to offer to Mr. Whale cordial congratulations on his attainment of so eminent a post, and to express every friendly wish that he may have an entirely successful and prosperous career in his new position.

FUTURE LONDON AND NORTH-WESTERN POSSIBILITIES.

It would, of course, be too "previous" as yet to speculate upon the future policy that may prevail at Crewe under this new chieftain. Rumours have not been wanting as to the likelihood of certain changes, but it may reasonably be taken for granted that Mr. Whale will not hurriedly take any new departure, but will wait awhile until he has had time to "look about him" and "feel his feet." Some rather extensive orders have lately been put in hand at the Crewe Works, and these will presumably, when completed, prove sufficient to satisfy immediate requirements. For example, ten more of the latest and largest type of four-cylinder compound expresses—of the "King Edward" class—have just been turned out carrying on the numbering of the four-cylinder express compounds from 1960 to 1970. There are now thirty of these large engines at work. They differ from their forty predecessors—known as the "Jubilee" type, which also are four-cylinder compounds—in having 16-in. high-pressure cylinders instead of 15-in., and 1,557 square feet of heating surface, as against 1,379 square feet in the earlier engines. It may be observed, however, that the additional heating surface is partly provided by a water bottom to the firebox, and it has yet to be seen whether that can be held to represent a proportionate enlargement of steam generative capacity. The later boilers, however, appear to be considerably larger than the earlier ones, and are higher pitched. When the "King Edwards" first appeared, a rumour obtained currency that they were to have 220 lb. of steam pressure instead of 200 lb.—the pressure allotted to the "Jubilees." This, however, was an error. The "King Edward" boilers were pressed to 200 lb., just as were the "Jubilee" boilers. But recently, in the case of both those classes of engines, it has been found preferable to work them at the reduced pressure of 175 lb. per square inch, which has been employed ever since 1884 in the three-cylinder compounds—those alike of the "Dreadnought," "Teutonic," "Greater Britain" and "John Hick" classes, seventy in all. It is understood also that the cylinders of some of the "King Edwards" have been lined up to 15 in., which certainly would appear likely to give a preferable ratio toward the low-pressure cylinders beside constituting a cubical capacity better proportioned to the capability of the boiler to supply "live" steam.

CYLINDER RATIO IN COMPOUND ENGINES.

It has often been noticed as a curiosity how radically the ratio adopted by Mr. Webb between the dimensions of high and low-pressure cylinders in his compound engines—the only compound locomotives at all numerous or extensively used in Britain—differs from that employed by M. de Glehn in *his* four-cylinder compounds which are the most widely used in the neighbouring country of France, and also how large a difference exists between the respective proportions of boiler power and cylinder area. Thus, whereas in his "King Edward" type Mr. Webb relies upon only 1,557 square feet of total heating surface to furnish "live"

steam to two high-pressure cylinders 16 in. in diameter, with a 24-in. piston stroke. M. de Glehn provides 2,275 square feet of heating surface to supply "live" steam to two high-pressure cylinders 13⅜ in. in diameter with 25½-in. piston stroke; and whereas the English engines have 16-in. high-pressure cylinders to 20½-in. low-pressure, the French engines have only 13⅜-in. high-pressure cylinders to 22-in. low-pressure; thirdly, the French engines work regularly with a steam pressure of 228 lb. to the square inch, while the English engines were originally built to carry 200 lb. steam pressure, but latterly have used only 175 lb. A difference so radical as this in what may almost be termed first principles between two locomotive engineers and locomotive designers of such remarkable eminence as Mr. Webb and M. de Glehn, seems to call for more attention and explanation than it has yet received. It may well be that each method can be defended upon theoretical and scientific grounds; in that case possibly the relative advantages of the two plans could best be determined by a comparison of the actual work performed. But it should be feasible, one would think, to determine *a priori* which plan is the more desirable to be adopted in case Great Britain should follow the example of almost every other nation in the world, and bring locomotive compounding into general adoption. It may be that even now the relative merits of the two systems could reasonably be decided by comparison of the work done. That, however, would be a purely *ex post facto* mode of decision, and it ought to be possible to determine beforehand what set of proportions would be likely to give the better results instead of first building a number of engines and waiting to see, by comparing their respective performances, which system was the better one. The latter would seem to be a costly and somewhat dilatory course. Yet, at the present time, railway authorities appear to be without any definite statement to guide them. The practice of England and the practice of France are diametrically opposed. When Mr. Webb desired to increase the power of his compounds he steadily enlarged the diameters of his high-pressure cylinders from their original 11½-in., successively to 13, 14, 15 and 16-in., while the cubical capacity of the low-pressure cylinders has remained without augmentation; indeed, in the latest types has undergone some diminution, the "Jubilees" and "King Edwards" having two [20½-in. low-pressure cylinders, whereas the earlier compounds—the three-cylinder type—namely, the "Dreadnought," "Teutonic," "Greater Britain" and "John Hick," had each one 30-in. low-pressure cylinder. M. de Glehn, on the other hand, seeks increased power by enlarging his *low*-pressure cylinders.

OTHER BRITISH COMPOUND SYSTEMS.

This diversity of ratio is found also in the other systems of locomotive compounding which have come into temporary or permanent use in this country. After Mr. Webb brought out his "Experiment" type in the years 1882-83, he was speedily followed in 1884 by Mr. T. W. Worsdell, on the Great Eastern, with his two-cylinder method in which his name has since been associated with the German engineer, Herr von Borries. The Great Eastern compounds, and the earlier North-Eastern compounds built after Mr. Worsdell had migrated to that line, had 18-in. high-pressure cylinders, 26-in. low-pressure, but the latest ten North-Eastern compounds built by Mr. Worsdell had cylinders respectively 20-in. and 28 in. in diameter, and so had the first compound engine brought out by his brother and successor, Mr. Wilson Worsdell, No. 1619, which has since been converted into three-cylinder compound with one 19-in. high-pressure and two 20-in. low-pressure cylinders, while the two compounds recently built for the Midland line by Mr. S. W. Johnson, have one 19-in. high-pressure and two 21-in. low-pressure cylinders. Thus the divergence of view in this respect is very remarkable, and at present there seems little chance of convergence. This is perhaps unfortunate, as it tends to delay the general adoption in Great Britain of a plan which has been found both efficient and economical in most other countries. Manifestly on the very threshold of a general movement for the introduction of compound locomotives, stands the question of principle—WHAT IS THE MOST ADVANTAGEOUS DIMENSIONAL RATIO BETWEEN HIGH AND LOW-PRESSURE CYLINDERS? It is possible that this question may be illumined in some degree by the performances of the Great Western compound which is expected to be at work about October next. A comparison of results as between those yielded by this engine and those by the North-Western and Midland compounds will necessarily possess the utmost interest, and practical as well as theoretical value.

THE CALEDONIAN TWIN GIANTS.

No. 50, the second of the new gigantic non-compound engines which Mr. J. F. M'Intosh has designed and built for the Caledonian Railway, is now out of the shops. Its precursor, No. 49, has been doing preliminary trial work with much success, and both engines should be ready to take their full share in the heavy tourist traffic of the present season. That they ought to give a good account of themselves may reasonably be assumed; that they will haul immense loads with ease and swiftness over the greater part of the Caledonian line may be regarded as certain. The grand practical problem is—What results will they give on the Beattock bank, especially on those last six miles of 1 in 75 continuously? That they should maintain really high speeds up such a gradient with heavy loads is not to be expected for one moment; of such a feat as that no locomotive ever yet built is capable. But Nos. 49 and 50 should each be able to take a 300-ton load up Beattock without allowing the speed to drop greatly below thirty miles an hour. In a number of tests made by the writer of these notes during the year 1896, when Mr. M'Intosh's earliest engines, the "Dunalastairs," came out, those engines which had only 18½-in. cylinders, four-coupled 6-ft. 6-in.

wheels and 1,400 square feet of heating surface, over and over again maintained a minimum speed of 50 miles an hour to the top of that formidable bank, hauling loads of 150 to 180 tons behind the tender. The new engines, which have 21-in. cylinders 2,400 square feet of heating surface, and six coupled 6-ft. 6-in. wheels, ought, therefore, to be able to do what is suggested above. If so, they will have accomplished a valuable achievement, and will thoroughly have justified their existence. More than that, they will have shown the way to a really practical method of avoiding the prevalent piloting and banking which at present disfigure the work of so many of our railways.

NEW LONDON AND NORTH-WESTERN GOODS ENGINES.

In addition to building ten more of the huge eight-coupled four-cylinder compounds for goods traffic, the Crewe Works have just brought out a locomotive type which is an entire novelty on the London and North-Western. It is, according to the old American nomenclature, a "ten-wheeler"; according to the newer plan of class designation, it is of the "4–6" class—that is to say, it has six-coupled wheels and a leading four-wheel bogie. Presumably it is designed to do the work which has hitherto been allotted to what are known as the "18-in." goods engines, which are non-compound, and have six-coupled 5-ft. wheels but no bogies. No. 1400, the pioneer of the new class, also has six-coupled wheels 5 ft. in diameter, but has a leading bogie as well. It is noteworthy that the London and North-Western run many passenger trains, including some of their fast expresses, with the "18-in." goods engines. If this class of duty can be advantageously performed by engines with six-coupled 5-ft. wheels, there seems little doubt that it could be done more efficiently by the new "1400" type, in which there is a much shorter length of rigid wheel base. On most of the French railways a large amount of good express work is performed by four-cylinder compound engines of the "4-6" type, with coupled wheels ranging from 4 ft. 9 in. to 5 ft. 3 in. and 5 ft. 9 in. in diameter. The larger wheels appear to give the better results on the whole, but all do well, and it seems to be coming more and more into recognition that the prejudice alike against six-coupled wheels and against wheels of small diameter for express work is in a large degree unfounded. Manifestly an enormous increment of adhesion weight is secured, and the theoretical attendant drawbacks have undoubtedly been a good deal exaggerated. In practice at any rate they have not been found to be nearly so formidable as had been foreshadowed in theory.

TAPER BOILERS.

A variant of the type of boiler, known in the United States as the "extended wagon top," has come into use in this country, and appears likely to enjoy considerable vogue. Probably the goods engines imported by the Midland Company two or three years ago from the Swedish Works rank among the earliest locomotives used on British metals to have the extended wagon top boiler. But the most recently constructed locomotives on the Great Western Railway, those intended alike for passenger and for goods service, have boilers with a material taper outward toward the firebox end. These possess the manifest advantage of having the largest area of heating surface in the locality where it is most valuable, namely, in the immediate vicinity of the firebox. Consequently the new Great Western boilers ought to exhibit distinct superiority in their facility of steam generation. Some of the latest "Mogul" type of goods engines have boilers of this class, and so has No. 3433, "City of Bath"—one of a new batch of 6-ft. 8-in. four-coupled express engines with cylinders 18 in. by 26 in. and leading four-wheel bogies, belonging except for their different boilers, to the well known and highly efficient "Atbara" class, which have been the standard express engines on the Great Western during the last few years. It may be added that an engine of the "Atbara" type holds the record for absolute maximum speed among all British or European locomotives.

THE ETERNAL AUTOMATIC-COUPLINGS QUESTION.

The automatic couplings question, like the poor, may be said to be "always with us," and doubtless will form the subject of keen controversy for many a day yet to come. But it really does begin to look as if a substantial step had at last been taken in the direction of solving this long insoluble problem. On several English railways a new automatic buffer-coupling is going through a course of experiment, and so far seems to have passed the ordeal with signal success. It is the invention of Mr. Allison Smith, formerly Chief Locomotive Superintendent on the Victorian Government Railways, Australia, and previously on the Government Railways of New Zealand. This automatic buffer-coupling, which he designates by its initials the "A.B.C." system, consists of three parts only: the buffer-head, which is a steel casting or forging; the shackle and the pin. Both ends of the wagon fitted with it are exactly alike, while the release gear consists of two parts only, the operating rod with a short crank in the middle bent at both ends for handles, and a short connecting handle, which joins the gear to the small tails on the end of the shackles. It is supplemented by a new swivelling lever draw-gear invented by the same engineer, and the combination of these two different inventions has given in experimental trial most valuable results. The cost of conversion is estimated by the inventor not to exceed £7 per wagon, while he calculates that through the greater lightness and simplicity of the gear, a reduction of nine cwts. is effected in the dead weight of each wagon, so that its carrying capacity is augmented by the same amount. If these figures can be borne out by practical experience, as some tests personally made by the writer lead him to believe probable, one of the most troublesome problems in all railway management would appear to be within measureable distance of solution at a relatively small cost.

C. R.-M.



A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

MACHINE TOOLS THE MOUNTING OF ELECTRIC MOTORS.

THE various methods of mounting electric motors for driving machine tools afford an interesting study in ideas, and they illustrate the fact that no such thing as uniformity in practice is yet in sight. The problem is partly affected by the selection of constant speed motors, or of the variable speed type. Using the constant speed, the step cones must be retained to produce variable rates of driving, and these, in the writer's opinion, should not be retained, and in all probability will disappear in favour of an all-electric drive, in which speeds are regulated by the controller with far greater facility and better graduation than by belt shifting.

Motors are variously placed below, above, at the back, or side, or within the machine. But the position is often determined more by the convenience of fitting it to existing patterns of machines with as little alteration as possible in design, than from other considerations. The most favourable location would appear to be in or adjacent to the base, because less vibration is produced in that position than when placed above the machine. Yet there are many examples of the latter. A good firm of lathe makers has recently abandoned the practice of placing the motors in headstocks in favour of putting them in, or behind the base. When, as in most cases, the belting must be brought from motor to machine, the shortness of belt drive, inevitable in many instances, is a source of trouble, due to the difficulty of taking up its slack. This is just the same trouble which the makers of rope travelling cranes have experienced. From this particular aspect the fitting of an overhead motor possesses some advantages, as an easily operated belt-tightening arrangement can be fitted. But the vibration is a strong objection to this form, while the aspect is top-heavy.

The real economy of the electric motor in machine driving does not lie in a reduction in capital outlay, as compared with the system of shafting and belting, for it costs more, but in its greater convenience and flexibility. It is a simpler system, it is more favourable to the access of light, and best of all, it permits of more ready variations in speed to suit a large range of work than belt systems do. We know the trouble of shifting belts, and that rather than submit to it men will run machines at unsuitable speeds. Moreover, the common belt variations go by big steps instead of in small gradations. The electric drive, therefore, is less a question of power, or economy, than one of flexibility.

The question of effecting changes, therefore, must be referred to the needs of particular shops. From this point of view, the advantage of the introduction of electricity lies chiefly in those shops where great and frequent variations in speeds are wanted for the most economical production. It might not pay to make such sweeping changes in works where the speeds seldom require changing—the belts are good enough then. Under the opposite conditions, it would generally pay to do so.

The two leading innovations in recent machine tool practice are destined to change the aspect of designs, and modify shop practice in more ways than it is possible to foresee. It is a rather disturbing thought to firms who have been remodelling and renewing their tool plant, that a very few years may probably see much of it unfit to compete with the changed conditions that are impending. Couple the two facts—the motor drive, and the high speed tool steels, and you have ample justification for such a forecast. Tools will be valued in proportion to their slogging capacities, to the quantity of cuttings which they will remove in a day. It will become a race between the motor-driven tool, and the strength and stiffness of the machine, and in the struggle it may happen that the very outlines of the machines, as well as their details, will become subject to great alterations. Already there are indications of these alterations in recent machines, and the tendency will be for them to become more pronounced.

THE TRAINING OF ENGINEERS.

A good deal is being written about the training of engineers. Amidst so many expressions of opinion, the writer may be permitted to state his own convictions with

regard to one or two points. First, from a long experience of shop conditions, the conviction is strong that little good will ever result from schemes of technical education for the workers, while the six o'clock morning start is insisted on in the case of apprentices studying at night. It means burning the candle at both ends, and in the middle too. Of course, exceptional cases might be quoted of youths who have surmounted these and other difficulties, but when a general system of education is discussed, it is idle to apply the case of youths of exceptional ability, energy, and health to that of the whole number. If apprentices study during winter sessions they should be permitted to lose quarters during that period, but without stoppage of wages.

Then, in the second place, the question of the "sandwich" system of training, which does not touch the case of apprentices, but that of pupils, has in its favour the fact that it is working well in many centres of industry. The chief difficulty lies in the solution of the question whether youths should be tumbled into the factory first, or spend a preliminary period at the technical school. The writer thinks that no practical man would advise the latter system. You cannot teach technical matters from models and books. Either a youth must be fairly well acquainted with the interior of a factory and its methods, or the technical school must possess a good workshop under the supervision of a thoroughly practical man. In any scheme of technical education the practical side must predominate, lest the student workers become overmuch addicted to theory, which is after all but the useful handmaid to successful manufacture. Wherever the training of the engineer begins, there the most powerful impressions will be gathered. It is a mistake, therefore, to acquire a permanent set in a technical school, which may colour all one's after life. Training should begin with practice, to be aided subsequently by theory, and then the two should alternate during several years.

THE PAYMENT OF WORKMEN.

The difficulties which surround the payment of workmen seem well-nigh insuperable. They do not occur in the case of professional men, nor to any great extent in that of salaried officials. There is always something unsatisfactory in the wages methods adopted in factories. Day wages lack stimulus, piece rates are traps to catch the unwary. No smart workman dares earn to his full capacity. The best men could often earn twice, three times the balances of the indifferent hands. But they must not do so, because the good days would not last. Prices would be cut, when about time and a half is exceeded. And so the best men keep down the product to perhaps one half or two-thirds that of which they are capable. There is such a thing in the shops as working hard and doing little. And for this the impolitic procedure of cutting down balances is responsible.

Of course, when improved methods of working—labour-saving devices, new machines, and so on—are introduced, piecework prices require to be readjusted. To this the men seldom object, but they do take exception to the reductions which are enforced simply on account of the big balances earned. Employers and men jointly should be capable of fixing fair prices for jobs on which previous experience has been gained, and these should not be altered, however high the men's earnings, except in consequence of the introduction of improved methods. It is not in human nature to put forth its best efforts unless assured of a secure and permanent basis of remuneration in return for those labours. These facts must be borne in mind in all methods of payment, whether by the piece, by bonus, or by premium. The latter certainly promises much, but time alone will test its permanence. It merits extended trial, and if it should abolish the deadening time wages, and the tricky piecework, it will be a boon to employers and workmen.

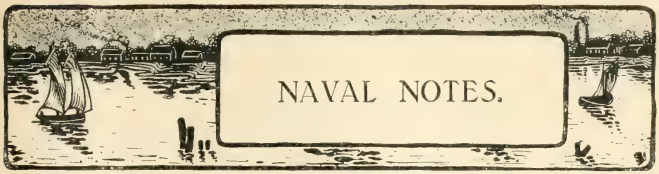
THE VILTER FOUNDRY.

Every works establishment has some special features which are not seen elsewhere. In the new foundry of the Vilter Manufacturing Company of Milwaukee, the spout of the cupola is raised high up in order that the largest ladle may be inserted underneath it. This is done with the object of avoiding the usual custom of digging a hole underneath the spout as often as a big ladle has to be used. As the spout is then too high to permit of holding the small ladles up to it, this difficulty is overcome by carrying a mixing ladle on trunnions fixed on a carriage, which is brought under the spout on tracks. Labour is thus saved, and mess avoided.

Another novelty is, that the doors of the core ovens are opened and closed by means of an air hoist cylinder, that can be operated by a boy; the idea being that time will be saved in the long run. Another device refers to the making of large moulds in the floor. Instead of having unprotected edges of sand, the moulding area is enclosed by a cast-iron curb of circular form.

CRANE DESIGN.

Something of a similar kind is happening in crane design to that which is going on in machine tools. The motor drive and high speeds are changing very much of the details of this class of mechanism. In the cage of the traveller, the attendant, seated comfortably, moves the three handles of the controllers to impart the several movements required. In many recent designs the controller levers are coupled together by universal joints, so that one handle only is used to operate. Frequently the three controllers are grouped together and worked by a single lever, and this is arranged to move in the same direction as the the load to be moved, backwards, and forwards, for the crab travel, sideways for the bridge travel, and up and down for the lifting. The result is great simplicity of control, and the operator is better able to observe the load. The application of electricity moreover gives in one type of crane a large range of speeds without complicated gears. The mechanical work put into electrical cranes also is much modified, some of it being of a very high class character.



NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

THE new Admiralty scheme has continued to attract a good deal of attention. While those who are opposed to it appear to be few in number, they are evidently determined to place their views on record. In the House of Commons the attack was led by Mr. T. G. Bowles, in the House of Lords by the Earl of Glasgow, who, as a lieutenant and a commander, saw considerable service in the Navy, before he retired in 1878; while in the press Vice-Admiral C. C. P. Fitzgerald appears to head the malcontents. It is unnecessary here to repeat the arguments used on both sides, particularly as the objectors have been fully answered by Lord Selborne, whose convincing reply in the House of Lords has been received throughout the country with approbation. It is more to the purpose to record the progress which has been made in carrying out the scheme.

First of all, although the discussion has mainly centred about one or two details connected with the scheme as it relates to the officers, it is well to repeat that it does not only refer to those who are to do their duty on the quarter deck, but to every class and grade of officer and man. The keynote of the scheme is unquestionably to be found in the necessity for assimilating the crew of a warship to its environment. A man-of-war has for some time past become more and more a scientific instrument, full of mechanical apparatus. And, therefore, if the most effective use is to be made of this engine of war, all those on board must have some knowledge not only of the practical handling of its parts, but of the theory which is at the back of them. In a word, the officers who handle the vessels must be engineers and the men mechanics. For this reason it is essential that the training of officers and men should be adjusted to the new conditions, and that on the common foundation thus laid, continuous and systematic specialisation shall be carried out.

As regards the officers, the various steps taken in training are consistent and consecutive. The cadet, on joining the Osborne establishment, commences his training by a course in which more than half his time will be devoted to engineering instruction: mathematics, mechanics and physics being considered essential training for an engineer. The remainder of his time will be devoted to the studies of language, literature, including history and geography, seamanship, and gymnastics. Passing from this stage, he goes to sea to acquire that knowledge which must be imparted in a naval atmosphere. The next stage includes preparation for an examination in such matters as gunnery, torpedo, engineering, navigation, pilotage, signalling, and general knowledge. It is now that specialisation begins. But only in the case of a certain proportion of the lieutenants. The greater number have by this time a sufficient knowledge to enable them to undertake the general duties of an executive officer, whether it be connected with the handling of the ship, fighting the guns, or directing the motive power. These duties require a simple straightforward knowledge of the mechanical parts of the ship, and their uses, such as may be obtained by any man of ordinary intelligence who has been given the mental training, the sea experience and general

equipment provided for under the new scheme. Moreover, these officers, before they can attain the rank of commander, will have to pass a further examination in subjects relating to strategy, tactics, naval law, and other matters fitting them for high command.

For the officers who specialise, whether in the science of gunnery, torpedoes, engineering or navigation, special courses will be arranged. These officers, too, will be divided into different categories, depending upon the capacity of the officer, only the more highly gifted taking the longer and more advanced course, fitting them for staff appointments in the educational establishments, the dockyards, and at the Admiralty. But the fundamental principle of the scheme is that every officer shall be given that training which will fit him for the command of ships and fleets, and that whatever special branch he may take up this shall be his ultimate ambition and aspiration.

Among other changes, therefore, which are to take place, and which, indeed, are in process of taking place, we have the establishment of the Osborne College, to be opened next August, with its naval and civilian instructional staff, a re-adjustment of the *Britannia* establishment, into which the cadets will flow from Osborne, and where they will undergo a further course of training, and the provision of vessels in which the cadets can acquire their sea knowledge. Next, the re-arrangement of the courses for officers specialising or passing for lieutenant, the probability being that the latter examination will take place at Portsmouth, and that Greenwich will become the place of instruction only for the higher and more specialised studies. Finally, it is proposed to establish a naval war college at Portsmouth, in order to prepare for the systematic education of officers of the highest rank; in fact, a school for admirals.

Simultaneously with these preparations for the better training of officers we have those for the making of the seaman into a mechanic. In the boys' training ships the instruction in sail drill disappears, and in its place the use of tools and other practical mechanical training will be given; the instruction in gunnery is also to be increased, and those boys who prove themselves good marksmen or display special aptitude for mechanical training will be encouraged to prepare for specialisation. All ordinary seamen, too, will be taught mechanical and stokehold work, and will have to pass an examination in this and in gunnery before being rated able-seamen. Further changes are to be made in the present method of training in gunnery and torpedoes. Part of this instruction, when the men are in barracks, will be carried out in the ships in the reserve, and these vessels will be taken from the basin and moored in the stream, where they will be supplied with nucleus crews able to take the ships to sea and practise firing with them. Only the higher torpedo and gunnery ratings will go to the schools, and from these again a selection will be made. Thus the scheme of systematic specialisation will go on.

Reference has already been made in these notes to the introduction of boy artificers, and satisfactory results are reported of the first entries who came from Greenwich School. The stokers, too, are encouraged to specialise, by the institution of new ranks and grades, and the opportunities opened up of attaining to warrant and even commissioned rank.

GREAT BRITAIN.

During the month under review few events of interest in connection with the building programme occurred. But before many weeks have passed we should see some tangible demonstration of progress. The three ships first ordered of the *King Edward VII.* class are all in a forward state and practically ready to take the water. The *Commonwealth* was launched on May 13th, but at the time of writing it is uncertain if a date has been fixed for the launch of the *Dominion*. After these three vessels interest lies with the *Queen* and *Prince of Wales*, both of which ships should be ready for their trials shortly. Attention is still attracted also to the *Duncan* class, the *Duncan* and the *Montagu* having commenced their gun trials in April. This latter vessel and the *Albemarle*, a sister ship, are expected before the autumn to have relieved the *Repulse* and *Victorious* in the Mediterranean. The *Duncan* will become Lord Charles Beresford's flagship in the Channel Squadron. Particular interest attached to the gun trials of the *Montagu*, in regard to a test of her 12-in. 50-ton guns mounted aft. These guns were fired simultaneously with projectiles of 850 lb. each propelled by charges of cordite weighing 212 lb. The velocity given to the projectile was equal to 2,600 foot-seconds, the muzzle energy being 39,850 foot-tons. A rapidity trial was also made, six rounds being fired in one minute fifty-five seconds. The gun trials of the *Duncan* have also been satisfactorily completed. Her 12-in. guns were fired with a charge of 244 lb. of cordite, being 24 lb. in excess of what had been

previously recognised as the maximum, and it was found that the Elswick mounting stood the strain very well. Moreover, the concussion did not affect the ship structurally, nor produce a shock among the working parts in the loading chamber below the barbette.

Turning to cruisers, it is stated that the *Duke of Edinburgh* is to show a phenomenal rate of construction, although at the same time it is reported that there will be delays in the delivery of armour. In spite of this delay it seems likely that both the *Duke of Edinburgh* and the *Black Prince* may be launched during the current financial year. We may also see several of the *Devonshire* class in the water during the same period. The *Devonshire*, the name ship of the class, will probably be put off the slips in July, and Lord Selborne, when visiting the Clyde, was said to be favourably impressed with the progress of the cruisers building in the yards there. Of completed ships, the *Spartiate* left for China; she made the voyage at a speed of 13 knots, and her coal consumption was to be carefully measured during the run. The total amount burnt was 2,600 tons, which gives an average of 21b. per i.h.p. for all purposes. The *Eurydus*, having completed her gun trials satisfactorily, began her steam trials, but had to abandon them twice owing to leakage in the condensers. The armoured cruiser *Monmouth*, to whose trials reference was made last month, attained on April 30th on the Chesil Beach course a speed of 22·8 knots. This is below her contract speed, but it is to be presumed that she will be accepted on it. It has been reported that the captain superintending the trials condemns this vessel as a bad sea boat, but the report is not confirmed. This is not the first time that rumours have been put in circulation as to the sea-going qualities of the *Kent* class, but these may be merely an echo of the criticism of the lines of this type of cruiser.

A report from the *Ariadne* states that on an eight hour trial at sea she made a mean speed of 20·5 knots, and on a twenty-four hours' run 19·1 knots. For commissioned trials these are very satisfactory performances, and go to prove that, as frequently insisted upon in these columns, vessels do keep up their trial speeds as a rule when in commission. It is well to remember that this ship is fitted with Belleville boilers.

No important particulars have yet transpired in connection with the design of the ships of the 1903–4 programme. It is believed, however, that the armoured cruisers will be very similar to the *Duke of Edinburgh* class, and the "scouts" on the same lines as those of the previous year's programme.

Of small vessels, the *Cadmus* was launched on April 29th at Sheerness, where her sister ship the *Clio* was built. She is to be ready for sea in December next, her engines of 1,400 h.p. are being supplied by Messrs. White and Co., of Cowes, and steam will be given by four Niclausse boilers. The *Merlin*, a similar sloop, was commissioned on May 1st to relieve the *Redbreast* in the East Indies. The *Clio*, which is also to be ready for sea in December, should make her preliminary trials in July; her engines are dockyard built. The *Arun*, torpedo-boat destroyer, was launched on April 29.

Torpedo-boat No. 112, which was launched by Messrs. Thornycroft in January last, has made her trials at Sheerness. With her full h.p. she realised a speed, the mean of three runs, of 22·311 knots.

Submarine A2 was launched at Barrow on April 16th; A3 being launched in May, and A4 in June. The four boats of the "A" class are 40 ft. longer than the earlier boats now at Portsmouth, which are a little more than 60 ft. in length.

FRANCE.

The battleships of the *République* class, about which there has been so much discussion, are, according to *La Yacht*, all to be built. Of these ships the *Justice* and *Patrie* are to be constructed at La Seyne, the *Liberté* at St. Nazaire, the *Vérité* at Bordeaux, and the *Democratie* is now to be built at Brest, where the *République*, which has already been launched, is completing. That the remaining five ships should be proceeded with is considered in France to be a triumph of good sense on the part of the Budget Committee. The following particulars of the dimensions of these ships is given in the same paper: Length, 439 ft.; beam, 70½ ft.; draught, 27 ft. 4 in.; displacement 15,000 tons. The normal i.h.p. will be about 10,500, and the maximum per contract 18,000, giving a speed of 18 knots. There is thus an increase of 500 h.p. in the new ships over that in the *République*, the machinery in which ship cost about £94,000, while that for the new ships will cost about £100,000. The boilers in some of the ships will be of the Niclausse type, and in others the Belleville. The coal supply will be 1,800 tons, giving a radius of action at ten knots of 8,300 miles. The protection of these ships will consist of a steel belt extending from the stem forward to nearly right aft, at which end there will be a transverse bulkhead 8 in. thick. This belt will reach from 7 ft. 5 in. above the normal water line to 4 ft. 10 in. below it, and will have a maximum thickness of 11 in. tapering to 6·4 in. at its upper and 3·93 in. at its lower edge. For some distance from the bow aft the belt will have a thickness of 7·2 in. at the water line, 5·5 in. at the upper edge, and 3·14 in. at the lower edge, and here it will reach from 8 ft. 3 in. above the water line to 9 ft. 9 in. below. The after part of the belt where it joins the bulkhead will be of a similar thickness and extend 7 ft. 6 in. above, and 3 ft. 2 in. below the water line. The teak backing of the belt will be 3·14 in. thick, with an inner plating of 0·78 in. The armament will consist of four 12-in. guns in two turrets, one forward and the other aft; eighteen 6·4-in. quick-firing, twelve of which will be mounted in turrets, in couples, three on each side of the upper deck, the other six being in a casemate amidships on the deck below, three on each side. There are also twenty-four 3-pounder 1·85-in. guns, two smaller guns for landing purposes, and five torpedo tubes. The turrets for the heavy guns will be protected with 11-in. armour in front, with 8-in. armour behind in the case of the fore

turret, and 4-in. armour behind in the case of that aft, the bases of the turrets being protected by 1·58-in. armour, while the hoods at the top are of 3-in. steel. The smaller turrets and the casemates will be protected by 6·3-in. steel, the hoods of the turrets being 1·75-in.; and in the casemates there are to be splinter bulkheads of 4-in. steel between the guns. The armour protecting the guns and the belt join one another. At some future time we shall hope to compare these vessels with the latest constructions of a similar character in this and other countries.

A rather curious list has been compiled by the *Petit Var* of the vessels which have been awaiting at Toulon the renewal of their boilers. These were twenty-eight in number, of which ten were batteships or cruisers. Since, however, the list was compiled two of the vessels named have been in use, but whether with their old boilers or new ones is not stated. The vessels in the Mediterranean fit for active service were at the time, according to the same authority, twenty-two in number. Turning to armoured cruisers, we have now received the details of the *Ernest Renan*. Originally designed for 12,600 tons displacement, 27,500 h.p., and 22 knot speed, she has been altered to 13,500 tons displacement, 36,000 h.p., and a speed of 23 knots. This is to be attained by using only six-sevenths of her boilers, which will be of the same type as those in the *Jeanne d'Arc*. But doubts have been expressed as to whether the *Renan* will succeed in making the stipulated 23 knots. Judging from what the *Jeanne d'Arc* did on her trials, the speed of the new vessel cannot reasonably be expected to exceed 22·11 knots, burning coal at the rate of 200 kilometres per square metre of grate surface. If this should be the case, she will be able, when in commission and under ordinary circumstances at sea, to make about 19 knots.

The *Amiral Aube*, a sister ship to the *Marseillaise*, has just been under trial, but the results have not appeared at the time of writing. The power contracted for is 20,500, and a penalty of £8 attaches to each h.p. below that figure. For the three hours' coal consumption trial, moreover, a penalty of £40 attaches to every 0·204 lb. per hour in excess of 34·8 lb. per square foot.

The *Bouvet*, battleship, is to be brought from the Mediterranean to Brest when the *Suffren* has completed her trials, probably about the beginning of the autumn. The *Guichen*, protected cruiser, and *Sagaie*, torpedo-boat destroyer, which have finished satisfactory trials, have joined the Northern Squadron.

The successes which have been reported in experimental trials by submarines and submersibles have thrown the Paris press into a fever of excitement. But it is doubtful if the results attained are actually all that the published records would lead us to believe. The *Narval* came into collision with a tug some time back, and because the tug was damaged and the submersible was not, it was confidently asserted that collision could not hurt these craft. A British submarine came into collision with a gunboat, and the gunboat was the more damaged, but we have not seen it stated that this circumstance proves the invulnerability of the submarine. It is beyond question, however, that the submarine has found a place in the warfare of the future, but what the limits of that place are, only time will show.

The *Arbalète*, torpedo-boat destroyer, of the *Fauconneau* type, was launched on April 28th, at Havre; while the *Arquebuse*, *Epieu* and *Javelin* have been on trial. The *Arquebuse*, which is fitted with Normand boilers, made a speed of 30·75 knots with 7,200 h.p.; the *Javelin* on a preliminary trial made 14 knots, the engines working satisfactorily, and subsequently on a full power run made 29·32 knots, with 7,000 h.p.; while the *Epieu*, which was built for 6,000 h.p., but whose power developed on trial is not reported, attained the unprecedented speed in the French navy of 31·21 knots.

GERMANY.

Details of the German Naval Budget for 1903, which have been published, show that there are eight new battleships, for which instalments are required, and eight which are undergoing structural alteration: four new armoured cruisers, and one undergoing structural alteration; eight new small cruisers, and one undergoing structural alteration; two new river gunboats, and two divisions of torpedo-boat destroyers. Of the new vessels the *Mecklenburg* and *Schwaben* each require a fourth and final instalment of £250,000 each for construction and £150,000 for guns, with a third and final instalment of £21,000 for torpedo armament. For H. and J. (the *Braunschweig* recently launched and a sister ship) a third instalment of £232,500 each is required for construction and £270,000 for guns, with a second instalment of £15,000 for torpedo armament. K. and L. each require second instalments of £267,600 for construction and £105,000 for guns, with a first instalment of £20,000 for torpedo armament. For M. and N., first instalments of £130,000 each, for construction, are required, and a further £150,000 for guns.

With regard to the four new large cruisers, the *Prinz Adalbert* requires a fourth and final instalment of £35,000 for guns; the *Prinz Friederich Karl* a third and final instalment of £254,500 for construction, with an additional £78,000 for guns and torpedo armament; the *Ersatz Kaiser* a second instalment of £210,000 for construction and 89,000 for guns and torpedo armament; and the *Ersatz Deutschland* a first instalment of £160,000 for construction, and £68,000 for guns and torpedo armament.

The *Schwaben*, battleship, was in May progressing rapidly at Wilhelmshaven, and it is expected that by November the vessel will be in commission. Her twelve boilers and three engines were in place, as well as the after funnel and the forward funnel was shortly to be erected. The boat cranes were also getting into place, and it was expected that before the end of June the guns would all be in position.

The *Mecklenburg*, a sister ship, was in May delivered to the authorities at Kiel, having run a satisfactory

delivery trial at Swinemunde. The new battleship M. the first of the improved *Braunschweigs*, has been laid down at Danzic. Her cost is expected to be something like £1,157,500. In length she is to be 406½ ft., with a beam of 70 ft., and her displacement is to be 13,000 tons. Her engines of 16,000 h.p. will drive her at the rate of 18 knots, and it is reported that the principal differences between her and the *Braunschweigs* will be in the thickness of her armour plating, which is to be heavier than any at present in use in the German Navy. N. is building at Gaarden.

The new cruiser *Ersatz Kaiser* is to be launched during Kiel week, while the battleships J. and L. should also take the water during the summer. In the autumn the only launch of importance at present expected is that of the battleship K. at the Vulcan Yard, Stettin. During the year the five vessels, *Mecklenburg*, *Schwaben*, *Prinz Adalbert*, *Undine* and *Arcona* should be completed and commissioned.

RUSSIA.

A commission appointed some time since to look into the advisability of further developing the Russian Navy has recommended that particular attention be paid to battleship and destroyer classes of vessels, and it further recommends that no cruisers of less than 6,000 tons displacement be built, as smaller vessels are neither good sea boats, nor useful as fighting units. Possibly in answer to these recommendations comes a report from St. Petersburg that five new battleships are to be laid down this summer. They are to displace 16,000 tons, and are intended to strengthen the Russian fleet in the Far East.

The new cruiser *Oleg*, building at the new Admiralty Yard, St. Petersburg, and announced to be launched by the Czar on May 14th, is to be fitted with Normand boilers, sixteen in number, supplying steam to triple-expansion engines developing 20,000 h.p., driving two propellers, and giving her a speed of 23 knots. Her normal load of coal, 720 tons, will last her three days at full speed, while her full capacity, 1,100 tons, will allow of a radius of action of 5,000 miles at 10 knots. Her two turrets, each containing a pair of 6-in. guns, will be of 1 in. thickness, and her armour belt will run two-thirds of her length, and it is proposed to fill in the space between the two sides underneath the armour deck with cork. She will carry two torpedo tubes on her broadside, but forward of the funnels.

Russian naval circles have recently been much interested in experiments which are to be carried out with some destroyers with a view to ascertaining the value of oil fuel. A naphtha engine of 6,000 h.p. has been ordered, and the results are eagerly awaited. Oil motors of this power have never been previously used, and should the experiments prove successful the Russian destroyer flotillas will be independent of coal, which will be a great saving on the present outlay on that form of fuel.

ITALY.

It is expected that the battleships *Regina Margherita* and the *Benedetto Brin* will be ready for commissioning by the end of this year. There has been considerable delay in the delivery of their armour plates, and again in the testing of them. Although progress on them is slow, the battleships *Regina Elena* and *Vittorio Emanuele III.* are fairly well advanced, but the work on the *Napoli* and *Roma* is slow, and falling in arrear. It is also reported that some alterations in the design of the armoured cruiser *Francesco Ferruccio* will cause considerable delay in the completion of this ship.

JAPAN.

The new programme of Japan is now placed at three battleships of similar design to the *King Edward VII.*, all to be built in England and completed in three years, three armoured cruisers, to be laid down next year, two in England and one in Japan, all of 11,000 tons and 22½ knots. It does not seem as if Japanese shipbuilding yards were yet capable of such a task, and it is more than likely that if the vessel is built in Japan it will be from British designs, and possibly with the assistance of a British firm of shipbuilders. Two protected cruisers of 5,000 tons are also included in this programme. All the ships are to be completed by 1913, which seems to indicate that all the battleships will not be laid down at once, even if the armoured cruisers are all laid down next year.

UNITED STATES.

The tenders requested for the construction of the three battleships *Vermont*, *Minnesota* and *Idaho*, which were authorised by the last Naval Act, describe these vessels very fully. The bids for them are to be opened on June 3rd. In considering the bids the Navy Department will, other things being equal, give preference to such as guarantee the shortest time for completion, and the maximum time allowed for completion will be limited to forty-two months. The vessels are to be of 16,000 tons displacement, and are required to make 18 knots, but will be accepted at a reduced price if they make as low as 17½ knots; below the latter speed they will only be accepted in the discretion of the Secretary of the Navy at a greatly reduced price to be settled upon by the Navy Department and the contractor. The general dimensions and features of the vessels are as follows: Length of load water line, 450 ft.; breadth, extreme, at load water line, 76 ft., 10 in.; mean draught to bottom of keel at trial displacement, 24 ft. 6 in.; gross draught, full load, about 26 ft. 9 in.; total coal bunker capacity, about 2,200 tons; coal carried on trial, 900 tons; feed water carried on trial, 66 tons.

The main batteries of the ships will consist of four 12-in. breech-loaders, eight 8-in. breech-loaders, and twelve 7-in. breech-loaders. Their secondary batteries will have twenty 3-in. 14-pounder guns, twelve 3-pounder semi-automatic guns, six 1-pounder automatic guns, two 1-pounder semi-automatic guns, two 3-in. field guns, two machine guns, calibre ·30, and six automatic guns, calibre ·30. The 12-in. guns will be mounted in pairs, in two electrically controlled, balanced, elliptical turrets, on the centre line, one forward and one aft, each with an arc of fire of about

270 deg. The 8-in. guns will be mounted in pairs, in four electrically controlled, balanced, elliptical turrets, two on each beam, at each end of the superstructure. The 7-in. guns will be mounted in broadside on pedestal mounts on the gun deck behind 7-in. armour, each gun being isolated by splinter bulkheads of nickel steel of from 1½ to 2 in. thick; forward and after guns arranged to fire right ahead and right astern, respectively; other 7-in. guns to have the usual broadside training.

The vessels will be protected at the water line by a complete belt of armour, 9 ft. 3 in. wide, having a uniform thickness of 9 in. for about 285 ft. amidships, forward and aft of which points the thickness is gradually decreased to 4 in. at the stem and stern. The lower casemate armour extends to the limits of the magazine spaces, and reaches from the top of the water line belt to the lower edge of the 7-in. gun ports on the main deck, and is 7 in. in thickness, the athwartship bulkheads at the ends of the casemate being 6 in. thick. The casemate armour around the 7-in. guns on the gun deck is 7 in. thick and the splinter bulkheads are from 1⅜ to 2 in. thick.

The protection of 3-in. guns is nickel steel 2 in. thick. The upper casemate athwartship armour, extending from the shell plating to the 12-in. barbettes, is to be 7 in. thick throughout. The 12-in. barbettes extend from the protective deck to about 4 ft. above the main deck, and consist of 10 in. of armour in front and 7½ in. in the rear above the gun deck. Between the gun deck and protective deck there will be a uniform thickness of 6 in. The barbettes will not have any special framing, the connection of the armour to the decks being sufficient. The 12-in. turrets will have a front plate of 12 in. thickness, rear plates 8 in. thick and top plates 2½ in. thick. The 8-in. barbettes will be 6 in. thick in front and 4 in. thick in rear, with the upper tube 3⅜ in. thick and the lower tube 3 in. thick. The 8-in. turret front plate will be 6½ in. thick, the rear plates 6 in. and the top plates 2 in. thick. The conning tower and shield will each be 9 in. thick.

The engines will be of the vertical, twin-screw, four-cylinder triple-expansion type of a combined horse-power of 16,500. Steam will be supplied by twelve water-tube boilers, placed in six watertight compartments.

Each battleship is to carry forty-two officers and 813 men.

The *West Virginia*, armoured cruiser, of 13,500 tons displacement, was launched from the Newport News Company's works on April 18th. This is the first of six similar vessels to take the water, her sister ship the *Colorado* was launched at Philadelphia, Cramp and Sons Yard, on April 25th, and the *Maryland* will probably be launched before these notes are issued. These vessels have already been described.

Last month I gave a list of the protected cruisers in hand in order of progress towards completion. The other vessels building are as follows: The *Florida*, a monitor, at the yard of Louis Nixon, the destroyer *Hopkins* at the Harlan and Hollingsworth Co., and *McDonough* at the Fore River Company, the torpedo-boats *Stringham* by Harlan and Hollingsworth, the *Goldsborough* by Wolff and Zwicker, the *Blakely* by Lawley and Sons, the *Nicholson* and *O'Brien* at the Nixon Works, and the *Tingey* at the Columbia Ironworks, the submarine boats *Plunger*, *Porpoise* and *Shark* at the Nixon Works, and the *Grampus* and *Pike* at the Union Ironworks.

MINOR NAVIES.

Spain.—The *Princesa de Asturias*, armoured cruiser of 7,000 tons, laid down in 1896, has made her trials at Cadiz. With 11,000 h.p. she made a speed of 17·5 knots. She is expected, with 15,000 h.p., to make 20 knots.

Holland.—Three new torpedo-boats under construction are to be named *Langka*, *Smerae*, and *Wajang*. These vessels are of 145 tons, and 25 knots, with a complement of twenty-four.

China. Two torpedo gunboats building at Foo Chou, the *Kien Wei* and the *Kien Ngan*, have been completed. *Le Yacht* gives the dimensions of these ships as follows: Displacement, 875 tons; length, 78 metres; beam, 29·25 metres; draught, 8·10 metres; h.p., 7,000; armament, one 100-millimetre gun, three 65-millimetre guns, six 37-millimetre guns, and two torpedo tubes; speed, 22·5-23 knots. But in Brassey's "Annual" these vessels are described as of 211 tons displacement; 260 ft. length; 36 ft. beam, 20 ft. draught; 1,600 h.p.; armament, two 8·2 in., six 5.9-in., six Maxims, and five light guns; speed, 14·5 knots.



AMERICAN RÉSUMÉ.

NEW YORK, May 10th, 1903.

New American Liner.

The *Minnesota*, the largest vessel ever built in America, was recently launched at the yards of the Eastern Shipbuilding Company, New London, Conn., a firm organised for the building of this ship and a sister ship still on the ways. Measured on the basis of maximum displacement, the *Minnesota* is the third largest steamship in the world, the *Celtic* and *Cedric* being her only superiors in weight. The following are the principal dimensions of the new ship: Overall length, 630 ft.; breadth, 73½ ft.; depth from keel to upper deck, 56 ft.; displacement at a draught of 33 ft., 33,000 tons, and at a maximum draught of 36½ ft., 37,000 tons. For the handling of cargo, there are two winches and two booms at each of the seventeen hatches, and all driven by electricity. For the storage of frozen meat one of the holds, having a capacity of 2,500 tons, is completely insulated, but so arranged that on the return trip it may carry ordinary freight. An unusual feature of the vessel is the location of the coal bunkers over the boilers, with chutes to deliver the coal on the floor in front of the furnaces. In addition to the regular bunker, with its capacity of over 4,000 tons, there is a reserve bunker of about half that capacity situated alongside the boiler room.

The boilers include sixteen of the Niclausse water-tube type, designed for 260 pounds pressure, and supplying steam to two triple-expansion engines, parallel to one another, and driving separate shafts. The engines combined, furnish 10,000 h.p., which is sufficient to drive the ship at about fourteen knots an hour with the 20-ft. propellers, making 78 revolutions per minute. The *Minnesota* and her twin ship will ply between Seattle and Yokohama, a distance of 5,800 miles, by way of Honolulu.

Powerful American Locomotive.

By an odd coincidence, the same month in which the largest American-built steamship is launched, sees also the completion of the most powerful locomotive ever produced. Like the steamship, the locomotive is shortly to be followed by a counterpart, both having been designed and built by the Baldwin Locomotive Works for the Chicago and Alton Railway, to provide for the heavy passenger trains which that road will be obliged to operate during the progress of the St. Louis Exposition. The engines will be required to haul trains of twelve cars, accommodating 760 passengers and weighing an estimated total (cars, passengers, and baggage) of 675 tons, a distance of 110½ miles, in two and one-half hours, at an average speed of 46 miles per hour, allowing for stops.

The total weight of the engine is about 219,500 pounds, of which 36,300 lb. is supported on the forward truck of four small wheels, 41,500 lb. on a pair of trailer wheels beneath the firebox, and the remainder, 141,700 lb., rests on the six connected 80-in. drivers. The cylinders are 22 in. in diameter, by 28-in. stroke, and are supplied with steam under a working pressure of 220 lb. per square inch. The tender, which is the largest the Baldwin Company has ever built, weighs 154,500 lb., and has a capacity of 8,400 gallons of water and 9 tons of coal. The boiler is 78 in. in diameter by 20 ft. long, and contains 328 2¼-in. tubes giving 3,848 square feet of heating surface. The firebox contains a grate having an area of 54 square feet, and is itself 9 ft. long, 6 ft. wide, and from 6 ft. to 5 ft. 4 in. deep, front to back, bringing the total heating surface up to 4,078 square feet, which is about 500 square feet more than the famous express engines on the New York Central Railroad have. Some conception of the tremendous power of these engines is afforded by the statement that the draw-bar pull, in other words, the tractive force, is over 15 tons, or, to be precise, 31,600 lb.

New Steam Turbine.

An event of the past month has been the disclosure, through a paper read before the American Philosophical Society, Philadelphia, Pa., by Mr. W. L. R. Emmet, of the first items of information to be made public by the General Electric Company, concerning a new steam turbine, which is now being manufactured, and has been the subject of experiment since 1895, when the inventor, Mr. C. G. Curtis, first made application for the patents. The machine has been developed under the direction of Mr. Curtis and other engineers of the General Electric Company, with a view particularly to adapting it to the driving of generators by direct connection. Already an aggregate of 230,000 h.p. of these turbine-generator units have been contracted for, a fact which would seem to indicate an established confidence in its claims for economy, simplicity, and efficiency, in spite of the fact that its advertising has but just begun.

The principle of the steam turbine is comparatively simple and similar to that of the water turbine or impulse wheel. In both the rotation and consequently the power are secured by the imparting of the speed of the acting fluid to the vanes of the rotor, the highest efficiency being obtained when the peripheral speed of the latter is one-half that of the fluid, or, in other words, if the fluid after impact is brought to rest. Herein lies a serious obstacle in the development of a successful steam turbine, which does not enter into the design of a water wheel, since steam in expanding acquires a very high velocity, which makes it prohibitive to attempt to remove the full energy of the steam by a single impact. The solution, as presented in the Curtis turbine provides a scheme for removing the energy in fractional amounts by causing the steam to strike successively against alternate fixed and rotating vanes of reverse curvature, each passage through a set of rotating vanes being designated as a stage.

Velocity is imparted to the steam in an expanding nozzle of special form designed to effect the conversion from force to velocity most efficiently. The nozzle is usually made up of several sections which may be opened or closed independently, affording the means of governing under light loads and passing the steam to the wheel in a broad belt when all nozzle sections are open. The number of stages and the number of lines of vanes in each stage are determined by the degree of expansion, the desired or practicable peripheral velocity and other conditions of mechanical expediency. A very striking feature of this new prime mover is its small size as compared with existing forms of the same capacity. For example, a plant which is now equipped with eight direct-connected engine-generator units of 5,000 h.p. each, contains more than enough floor space to accommodate forty turbine-generator units, each of the same capacity. At the same time, the head room required by the latter is but little over half that necessary for the engine unit. All of this may be resolved to the simple statement that the cubic contents of a turbine plant need not be much more than one-tenth that required in an engine plant of the same capacity.

Iron and Steel.

The past month has been marked by special dulness in the market for foundry iron. In the central west an unusual condition prevails, as practically the whole demand for the first half of this year was covered in 1902. Little provision has been made for the second half of the year in the hope that waiting will secure better prices, and the indications are that these conditions will be fulfilled. The consumption of foundry iron has by no means fallen off, and it is evident that a decrease of imports will soon compensate for the over-production, as the prices of domestic iron have made importation in any but small lots almost prohibitive, there being no chance of competing except on the coast.

Steel production, on the other hand, is decidedly behind the demand, due principally to the enormous call for finished material. Orders have been placed for structural steel for several large bridges and very many buildings, and the inadequate capacity of plants supplying that product offers an inviting market to the foreign trade. To meet the urgency of the situation, one large rail mill has already switched over to the rolling of steel billets, and it is not unlikely that other mills will follow the example. For a time labour difficulties threatened to hamper the structural trade, but many of these have been adjusted, concessions being warranted by the size of the prospective business. However, this cannot last, and a turn in the market will see a universal readjustment of wages.

Throughout the month the bar trade, in spite of good orders, has been quiet, since the mills manufacturing that line have ample capacity to fill all needs. Wire rods are scarce, and hold their price at a trifle below the foreign offering. The mills are pressed to their utmost, and not a little difficulty is experienced in securing raw material. The sheet market is very strong, and points to a probable advance in official prices within a short time. In spite of [illegible] the rail trade is considerably taxed there is an endeavour on the part of some manufacturers to regain the Pacific Coast and Canadian markets. Orders for merchant pipe have fallen off slightly but the mills are fully occupied with work at the present time, and the near future holds prospect of many good orders.

The Louisiana Purchase Exposition.

The formal dedication of the Louisiana Purchase Exposition, at St. Louis, Mo., took place April 30th, although the Fair proper will not be opened till next year. While comparatively little of the work is as yet completed, it is possible to give at this time a few items of interest concerning the engineering work. The grounds will cover a site of some 1,200 acres, or nearly twice the area devoted to the Columbian Exposition at Chicago in 1893. Of this, two-thirds was supplied by the city in the form of the western half of Forest Park. The remainder of the ground was leased from the Washington University, and upon this several large permanent buildings have been or will be erected, which at the end of the Fair will revert to the University. Among these, the main or Administration Building accommodates the Division of Works and the Department of Civil Engineering in the two wings.

Steam for power purposes will be furnished by boilers of various domestic and foreign makes, ranging from 150 h.p. to 1,000 h.p., some using forced and some induced draft, while others will burn fuel gas furnished by producers on the grounds. The power plant will be at the west end of the Machinery Building, and will consist of four steam-driven generators with an aggregate capacity of 8,000 kilowatts or 10,700 h.p. In addition 6,000 kilowatts, or, if necessary, 7,500 kilowatts, may be obtained from a local power plant, bringing the total available horse-power up to 20,770. The exhibition plant in the building will also supply a varying additional amount of never less than 5,000 h.p. The current supplied from the main plant will be of the three-phase alternating form at 25 cycles and 6,600 volts, and will be controlled from a huge switch-board arranged on a gallery extending across one end of the Machinery Hall. For illumination about 15,000 kilowatts will be required, of which 7,000 will be utilised in the interiors of the buildings and 8,000 on the grounds and exteriors. Probably the most spectacular feature of the exterior illumination will be that proposed for the cascades, whereby, by means of special apparatus behind the cascades, various coloured lights will be thrown on the falling sheets of water. For the distribution of current about the grounds some 100 miles of electric wire ducts will be used.

The scheme for intramural transportation is not yet fully decided upon. The most favoured plan makes use of an electric system consisting of a main belt line skirting the grounds with two loops to most effectively serve the greatest area. Part of the track will be a surface line with a fenced right of way, while the remainder will be borne on an elevated structure and screened artistically to make it as inoffensive as possible to the landscape. It will be a third rail system with standard types of motors so that they may be used for street or elevated railway service after the Exposition is over, and will include about six miles of single track.

THE MODERN CONTINUOUS ROLLING MILL

BY

AXEL SAHLIN.*

The author fully investigated this subject during a recent tour of study and inspection in the United States. Many of the original illustrations are reproduced by the courtesy of the Staffordshire Iron and Steel Institute.—Ed.

IN the history and development of the Continuous Rolling Mill it seems that France, America, and England have, in the order named, added their contributions to the solution of a problem which is now, and is still more destined to become, one of paramount importance to the steel manufacturing industry. It is, however, to Great Britain that the honour of the first really workable continuous mill belongs, while America may rightly claim to have developed, completed, and modified the British invention into what we to-day understand as a Modern Continuous Rolling Mill.

THE FIRST WORKABLE MILL.

The first practical success in continuous mill construction was achieved by the late Mr. Geo. Bedson, of Manchester, of whom Mr. C. H. Morgan says—"He first made the mill go."† Bedson mills, more or less modified, are yet, I understand, in operation in various places in England. The Bedson rod mill opened the way to the use of heavier billets, that is, longer wire rods, than it had been possible or practicable to roll on the Belgian mills. The English mill was, however, complicated, as it required alternate pairs of rolls to be placed vertically and horizontally. This change in position required two separate systems of gears and made the mill inaccessible. It, therefore, was left for Mr. Morgan to place in one horizontal plane all the gearing and all the rolls of his first mill, which was also the first of the modern type, and which was designed and built by him in 1878, at the works of the Washburn and Moen Manufacturing Company, at Worcester, Mass. In order to give to the billet working pressures at various angles and from different sides twist guides were introduced between some of the roll stands, by which the metal was turned 90 degrees before entering the following pass.

PRODUCTS.

The continuous system of rolling carries with it a limitation, which increases with the lack of skill of the roller. The reduction of the metal in these, as in other mills, is principally caused by the pressure of the rolls; but in order to ensure against overfeed, it is customary in the continuous mill for the roller to so adjust the rolls, that a certain slight stretch or tension permanently exists in the bar between each pair of rolls. This stretch measured in percentage is small, but it may slightly reduce the section of the bar. The lack of this small stretch at each extreme end of the bar leaves a couple of feet of the first and last ends slightly larger in section than all the intervening part. This is particularly the case in rolling very small sections which would buckle with the slightest overfeed. When rolling larger, hence stiffer, sections, this precaution of adjusting the rolls for stretching is unnecessary. In rolling billets, a careless roller may even have push instead of stretch. Pushing between the rolls, of course, leaves each short end slightly small instead of large.

The purely continuous mill, as at present designed, is, therefore, principally useful in the preparation of products or sections which may afterwards, if necessary, be finished in separate looping mills or drawn through dies. Billets and wire rods are to-day the principal products from the continuous mills, but great success has also been achieved in using this simple, automatic process, which renders the crop waste very small, for the production of smaller finished sections in long lengths. In the United States cotton ties are largely and most economically produced in purely continuous mills. At the Illinois Steel Company's works at Joliet, Ill., I saw a 10-in. continuous mill, which had

* Read before the Staffordshire Iron and Steel Institute.

† "Some Landmarks in the History of the Rolling Mill." A paper read before the American Society of Mechanical Engineers.

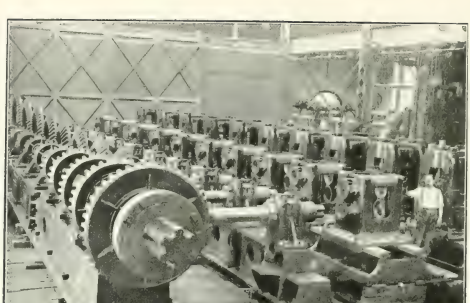


FIG. 1.—GENERAL ARRANGEMENT OF CONTINUOUS BILLET MILL.

an average record of over 180 tons per day of $\frac{5}{16}$-in. square spike bars of uniform sharp-cornered section and free from end fins. These bars were afterwards manufactured into railroad spikes in the company's own works.

The best arrangement for rolling a large range of merchant sections (squares, rounds, flats, crosses or light angles) has been found to be a continuous mill, followed by a certain number of stands of finishing rolls placed singly or in trains, through which the bar is repeated, and in which it is given its accurate, finish section. Such mills have during the last three years come into extensive use.

The modern continuous mills may be divided into three classes—billet mills, wire rod and cotton tie mills, merchant bar and light angle mills. None of these mills owe their economy or their productive capacity entirely to the roll train itself, but also, and largely to the ingenious accessories, which form, and must form, an important part of such a plant, in order to prepare and take care of the rapidly rolled product.

I.—THE CONTINUOUS BILLET MILL.

The continuous billet mill, fig. 1, consists of from six to twelve pairs of rolls placed tandem, but close to each other. Between every other pair of rolls, twist guides serve to turn the advancing steel an angle of 90 degrees. The rolls are driven through spindles and steel pinions by a series of bevel gears so proportioned that the speed of each succeeding pair of rolls will take up the elongation of the bar of metal produced by the preceding pass. All of these gears are driven [illegible] to the engine which, running fifty-five revolutions, indicates about 2,000 h.p. when taking billets from the blooming mill without reheating), and parallel with the axis of the mill. The practice mainly in use in America is to furnish the steel to the soaking pits of the blooming mill in ingots weighing from two tons to $3\frac{1}{2}$ tons. The soaking pits are of the ordinary Pittsburg type, each pit having four holes, each hole holding four ingots. The ingot is broken down on a reversing blooming mill into a billet 4 in. by 6 in., or $3\frac{1}{2}$ in. by 7 in. in section. In passing from the mill, the forward or top end of this billet is cut off in a hydraulic shear, and the billet is then in its entirety, without reheating, advanced to the continuous mill. It enters this at a relatively slow speed. It leaves the last pass as a billet $1\frac{1}{2}$ in. square, 600 to 1,000 feet long, running with a velocity of 500 ft. per minute.

No machinery previously devised in the form of shears or saws would have been able to cut this bar while in motion, or to cope with the tonnage produced.

THE "FLYING SHEAR."

It remained for the "Flying Shear," invented by Mr. V. E. Edwards, of Worcester, Mass., to solve this problem. This shear is shown by fig. 2. It consists in principle of an upright frame pivoted at its lower end, and carrying near the top the lower shear knife. Fastened to a slightly inclined pair of links, also pivoted at their lower end, and to the same bedplate as the upright frame, is the upper shear knife, which is hinged to a crosshead, guided in a groove in the first-mentioned vertical frame. If this vertical frame is pulled forward, the inclined links will drag the upper shear knife downward until it engages with the lower knife, when a bar advancing between the shear knives would immediately be cut. The shear then stops, having reached the end of its stroke, but the on-coming bar continues its uninterrupted motion and quickly pushes the hinged upper knife out of the way, thus allowing the shear to slowly return to its first position. In order to make this shear successful, it was necessary to design a contrivance which would at the proper moment drive the vertical frame forward with the same velocity as that of the advancing bar, and also to find means for promptly returning the shear to its original position. This double object was accomplished by special steam or hydraulic cylinders controlled by a trigger or electric contact. The action of the cylinder is regulated with such accuracy that

the time from the moment the bar strikes the trigger or electric contact until the cut has been completed may be controlled and known to within two-hundredths of one second, and the length of the cut billets to within 1 in. Even this slight variation is largely due to varying temperatures of the steel and to uneven speed of engine. Indicator diagrams have been taken which show, with unquestioned accuracy, the time occupied for each part of the movement of this "cut in transit."

The "Flying Shear" has made it possible to cut billets to any length from 12 ft. upwards, and to handle a steel bar several hundred feet long within a space a few feet wide, and only about 10 ft. longer than the billet which is being cut from it. After dropping from the shear, the billets advance on rollers to the assembling or "skew roll" table. In order to arrange this stream of billets into a neat bunch, preparatory to pushing them out on to the hot bed, the driven rollers of the table are set at an angle. The billets are, therefore, driven forward against an end stop, and broadside against a side straight edge, thus automatically and neatly grouping themselves side by side. An 8,000 lb. ingot gives thirty-five 1¾-in. by 30-ft. billets, and makes a bunch about five feet wide. Between the consecutive billets there is, of course, no delay, but between the consecutive ingots there is generally a clearance of, say, fifteen seconds. This allows time for pushing the bunch out on to the cooling bed by means of the side straight edge, which is driven from a motor by a pair of wire ropes. At the end of the cooling bed the cold billets are dropped into "I" shaped frames placed on a weigh bridge. Two chain slings are placed around the billets, which are handled in units of from ten to fifteen tons by an overhead crane, and loaded on cars for shipment or carried to the charging table of the furnaces of the finishing mills, as the case may require.

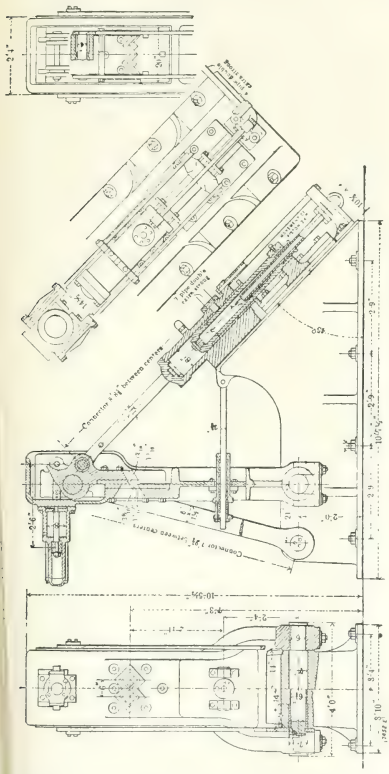


FIG. 2. STANDARD TYPE OF FLYING SHEAR.

The billet mill consists, generally, of rolls of from 14 in. to 16 in. diameter. The first rolls are made somewhat smaller in diameter than the later ones, so that when the roll is worn out it may be redressed and placed in the second pass ahead of the one in which it has previously been serving. A considerable economy in the consumption of rolls and in roll turning, is hereby effected. The roll housings, which rest on one common shoe or bedplate, are made of strong charcoal iron. The adjustment of the rolls is made by means of wedges, not by screws. The steel pinions are run in oil in hermetically closed housings. A mill of nine stands of rolls will reduce from 900 to 1,800 tons of 4-in. by 6-in. blooms into 1¾-in. billets in twenty-four hours. Including every man in any way connected with the mill, the number of workmen required is ten per shift, out of whom only the roller and engine driver need to be specially trained for their positions.

Owing to lightness of parts, low speed, continuity of stresses, and freedom from shocks, the wear and tear in this class of mills is very light. Repair charges are low. The continuous system is, therefore, rapidly

becoming a favourite means for production of the smaller billets now largely taking the place of the 4-in. by 4-in. section hitherto used as the commercial billet in the United States and rolling mill men are again returning to the smaller sizes of billets, which we in England have never ceased to recognise as the proper raw material from which to finish steel of small

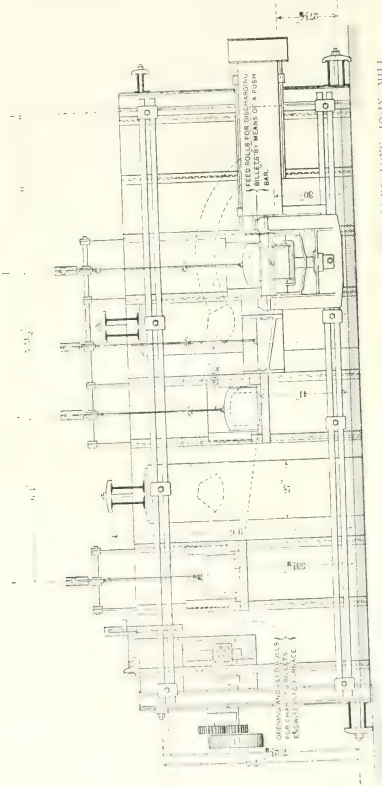


FIG. 3.—VIEW OF CHARGING END OF NATURAL GAS FURNACE FOR 2-IN. BILLETS, 30 FT. LONG, 10-IN. WIDE. MORGAN CONTINUOUS FURNACE.

section billet are:—(1) Economy in handling. (2) Facility for inspection. (3) Economy in reheating. (4) Uniformity of heat conditions, making it practicable to roll long lengths. (5) Economy in rolling.

The cost of a continuous 14-in. billet mill, with feed roller table, shears, delivery roller table, hot bed, crane, gearing, 2,000-h.p. compound-condensing engine, boilers, pumps, and building may be estimated at from £25,000 to £30,000, depending on location, completeness of appliances, and time of construction.

A continuous billet mill will make a yearly average of ninety-eight per cent. of cut billets, from 4-in. by 6-in. blooms. In the United States, the cost of rolling these small billets may be estimated from 1s. 3d. to 1s. 6d. per ton, including allowance for interest and depreciation. The fact that such firms as the Carnegie Steel Company, Jones and Laughlin Steel Company, National Steel Company, Republic Iron and Steel Company and Dominion Iron and Steel Company, and many others have installed continuous mills of large capacity is the best proof of their commercial and technical success.

II.—THE CONTINUOUS WIRE ROD AND COTTON TIE MILLS.

WIRE ROD MILLS.

The Belgian mill, as compared with continuous mills of these later years, has only one advantage as far as I can judge, that of low first cost of installation. The drawbacks, on the other hand are: (*a*) the impossibility of rolling long lengths of rods; (*b*) extra use of severe manual labour; (*c*) excessive consumption of power, that is steam fuel; (*d*) variable heat treatment of steel, the first and last ends of the rod leaving the finishing rolls at widely different temperatures, causing a variation in hardness or "temper" and also in dimension, both of which irregularities are positively felt in wire-drawing departments where continuous rolled and loop rolled rods are enclosed side by side.

The only wholly continuous rod mill on the market in the United States is constructed by the Morgan Construction Company, and is the outcome of thirty-four years of unceasing study, observation, and improvement. The mill consists of two trains of continuous rolls. The [illegible] receives the 4-in. square billet [illegible] directly from the heating furnace and reduces it in six passes of roll, or 12-in. rolls, to a section [illegible] The forward end of this last [illegible]

scropped in a flying-shear after leaving the roughing train, and passes through a tube-shaped guide into the first pass of the eight continuous stands of 10-in. finishing rolls. The mill may roll one single wire rod at a time, or two wire rods side by side. The action should be continuous, a fresh billet entering the mill within 6 in. of the rear end of the previous billet. The housings are placed on continuous bed plates. The adjustment of the rolls is made by wedges. The rolls for each pass are gradually somewhat increased in diameter towards the finishing pass, the rolls for which are generally turned with twenty-four grooves, all of which can be used, one after the other, until the whole surface of the roll is worn out. Not until then is it necessary to change rolls. The worn-out finishing roll may be re-dressed and used in the third pass from the last, afterwards in the fifth pass, and then in the seventh. In the same way, the rolls in the roughing train may from time to time be re-turned and used in the previous roughing passes. The high-speed rolls are driven through spindles from machine-cut steel pinions running in oil in hermetically closed housings. Both trains are driven by one engine, which should have a capacity of 1,000 i.h.p. for one strand, or 1,600 i.h.p. for double strands. The pinions of the roughing train are turned by direct gearing from the engine shaft, while the finishing train is usually driven by two leather belts, one riding on top of the other. Each belt drives two pulleys, and each pulley, by a nest of cylindrical gears, drives two stands of rolls.

The billets arrive from the billet mill in bundles of from ten to fifteen tons, held together by two sling chains. They measure, as a rule, 30 ft. in length, with a section of 1¾ in. square. The weight of each billet should for best economy be not less than 300 lb.

The billets are automatically fed into a Morgan Continuous Furnace having a suspended roof. The furnace (figs. 3, 4 and 5), is an integral and necessary part of the rod mill. Its bed usually measures 32 ft. by 20 ft. It slopes towards the hot, or discharging end, at a pitch of 2 in. to the foot. The upper part of the furnace bed consists of water cooled pipes or "skids" on which the billets rest. The central part of the furnace bed is formed with fire-brick; the lower, the hottest, part is paved with magnesite brick. The roof is turned in three arches, each having about 7 ft. span. The hanging skew backs for these arches are supported by 2-in. double extra heavy pipes, through which water is flowing. These pipes are suspended from steel girders resting on the furnace walls. Special skew-back bricks, with semi-circular recesses, are placed over the pipe, and against the sloping faces of these bricks the roof arches rest. This construction has been in use since 1896, has proved very durable and

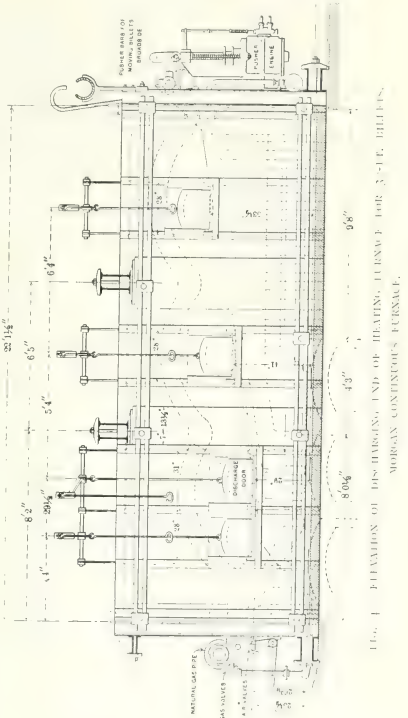


FIG. 4. ELEVATION OF DISCHARGE END OF HEATING FURNACE FOR 3-IN. BILLETS. MORGAN CONTINUOUS FURNACE.

satisfactory, and has a great advantage where used over a large and wide bed, as it makes it possible for the roof to be brought as closely as desired to the bed, thus securing uniform heating of the 30-ft. billets. Above the arched and refractory roof a hollow space

is formed by a second roof of corrugated iron, covered with sand. At the lower end of the furnace, air is admitted into this space, whence it is drawn by an exhaust fan. After passing through this fan, the air is returned to the space under the bed of the furnace. Here it passes through a stove built of fire-clay pipes, around which the products of combustion from the furnace play on their way to the smoke stack. The air is finally led under the bottom of the furnace into the fourteen air ports; each port being about 4½ in. square, and controlled by its own valve. The gas enters through fourteen gas ports, 9 in. by 1 3½ in. in size, each controlled by its independent, water-cooled slide valve. The gas is delivered into these ports through short flues directly from the adjacent gas producers, which will be described later.

The draught is entirely regulated by the exhaust fan. The smoke stack is simply a flue for conveying the products of combustion out of the building. The billet is delivered at the upper corner of the furnace on rollers. At this point it is gripped between two pinching feed rollers, which are placed flush with the inside of the furnace wall. These may be driven electrically or by belting. When the billet has been carried through these rollers, it is fairly within the furnace. A steam cylinder fastened to the furnace binding on the upper, cold side of the furnace turns a longitudinal shaft which is armed with five levers working push bars which enter into the interior of the furnace. By raising the piston of this steam cylinder, the push bars will be made to advance, pushing the billet forward about three inches. A new cold billet can now be entered between the pinching feed rollers and run into the furnace. The two are then advanced another step by the pushing device. In this manner the furnace bottom is gradually covered by one continuous layer of 1¾-in. billets. As they advance, these billets come into zones of higher temperature, and are gradually and uniformly heated until they arrive at the bottom, or hot, end of the furnace, thoroughly soaked and ready for rolling. The rod mill furnace contains about 120 billets, and can, without forcing, deliver 100 heated billets per hour. As long as the billets arrive at the mill fairly straight, the heating process is nearly automatic, one man feeding the furnace, another discharging the billets into the mill. The heater controls both furnace and gas producers. The working of the latter is indicated by gauges fastened to the furnace binding, close to the gas and air valves. Close to these gauges are valves regulating the steam [illegible] producer.

The delivery of the billet from the furnace into the [illegible] is effected by a second pair of driven pinching rolls. Between these is entered a push bar, the forward end of which is placed against the rear end of the billet. By pressing the rolls together against the push bar, the drawer forces the hot billet forward through a small door directly into the first pass of the mill.

The Morgan Gas Producers (fig. 5) are built in two [illegible] connected. Heat detail was prompted by the absolute importance of supplying for the continuous furnace a gas uniform in composition, temperature, and quantity. In the ordinary producer, a quantity of coal is periodically dropped in a pile into the producer. As this coal is being heated, the light hydro-carbons and water contained in it are quickly expelled in a flow of rich but cold gas. These products having departed, the percentage of carbonic oxide and acid, which are the products of combustion of the carbon in the coal, greatly increase in the gas, which, therefore, entirely changes its character and composition within a few minutes.

To obtain the necessary uniformity, a special rotating feed device has been designed, which, driven from an overhead countershaft, automatically discharges and spreads a certain, constant quantity of coal over the entire surface of the producer. This feed can be adjusted to run faster or slower without altering the regularity and continuity and distribution of the feed. It has further been found necessary to abandon the square form of hearth, still a bad feature in many favourite designs of producer, and to adopt throughout a circular section, in the centre of which the mixture of air and steam is introduced through an inverted tuyere.

The steam pressure usually varies from 6 lb. to 10 lb. per square inch, and is under full control of the heater in charge of the furnace. The gas-man's responsibility is limited to keeping his fuel bed and ashes of proper depth.

The thickness of the layer of ash and coal in the producer has a great influence on the composition of the gas. The best effect is obtained when ashes reach a line 3 ft. or thereabouts above the central tuyere, and are covered with a 2 ft. 6 in. layer of coal in various stages of combustion. A number of inspection holes piercing the shell and lining are, therefore, arranged at intervals around the producer at a level 3 ft. above the mouth of the tuyere, or in the plane where the coal ought to be completely consumed. By periodically removing the ashes, so that the bottom layer of coal reaches the level of the inspection holes, the desired quantity of ash may be left in the producer. The heated ashes, through which the mixture of air and steam must pass before coming in contact with the fuel, act as a sort of continuous regenerator, saving the heat left in the ash at the same time as the action of the steam serves to disintegrate the clinkers which, when bad coal is used, so greatly embarrass the operation of our ordinary producers. The average composition of the gas delivered by the Morgan producer is as follows:—

O	4 per cent.
CO	24·5 ,,
CO_2	3·7 ,,
H	17·8 ,,
N	49·8 ,,
CH_4	3·0 ,,
C_2H_4	3·2 ,,

It is desirable that the gas should enter the furnace [illegible] as hot as possible; therefore the producers are placed as closely as practicable to the heating furnace.

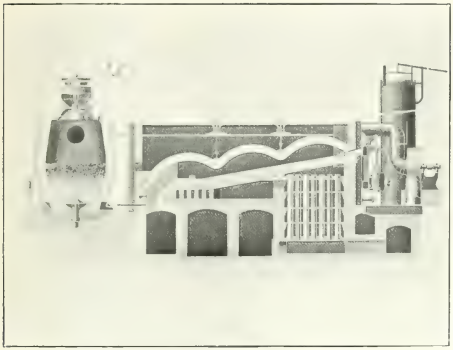


FIG. 5. SECTION OF FURNACE AND GAS PRODUCER.

As a definite record of the performance of the combined Morgan Producer and Furnace, it may be stated that the average quantity of fuel used for heating one ton of cold 1¾-in. billets for the rod mill at Grand Crossing Tack Company's works at South Chicago during the year 1902, was less than 150 lb. The coal used was of the average Illinois quality, which in ordinary producers gives a great deal of trouble from the accumulation of clinkers. I examined the ash pile at these works and found no clinker larger than a man's fist.

When the drawer, by means of his pinching rolls and the square pushing bar gripped between them, has pushed the hot billet through the delivery door, it enters directly through a "V" shaped guide into the first pass of the roughing train, which is placed close up against the wall of the furnace (fig. 7). The billet advances through the following passes, and through alternately straight or twisted guides at an increasing velocity, until it leaves the sixth pass in the form of a ½-in. square bar, which is cropped in a flying shear, so that the bar will invariably present a clean entering-end at the first of the eight finishing passes through which it successively and automatically advances. The velocity of the rod leaving the mill is about 2,000 ft. per minute. The time required for passing the first end of the billet through the fourteen passes is only about fifteen seconds, during which the rapid reduction from 1¾-in. square to No. 5 wire rod has taken place. The amount of mechanical work so rapidly expended on the small quantity of steel has the effect of heating the same nearly as much as the flood of cooling water on the rolls lowers its temperature, so that the rod leaves the mill at a heat only slightly less than that at which the billet entered the first pass. In the furnace the heating has been so gentle, and the atmosphere so reducing, that no slag is formed and very little oxidation has taken place. Some scales which cover the billet when they reach the factory will be found lying dry on the magnesite brick at the lower end of the furnace, whence they may be periodically scraped off and removed. In passing through the mill, the rod is for the greater part of the time running through guides, or under water with which the rolls are being sprayed. The oxidation during the time of rolling is, therefore, brought down to a minimum. To protect the rod from oxidation after leaving the mill, it is led through a pipe some 50 ft. long through which water is continually flowing (fig. 8). In this the rod is rapidly cooled, without being exposed to the oxygen of the atmosphere

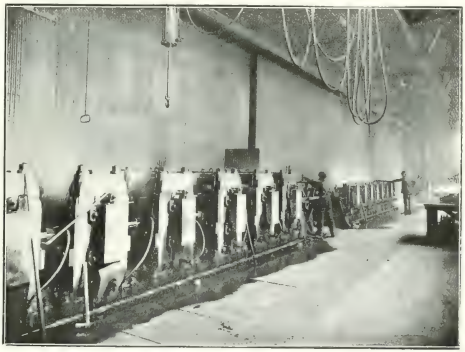


FIG. 7. MORGAN CONTINUOUS ROD MILL. ROUGHING END.

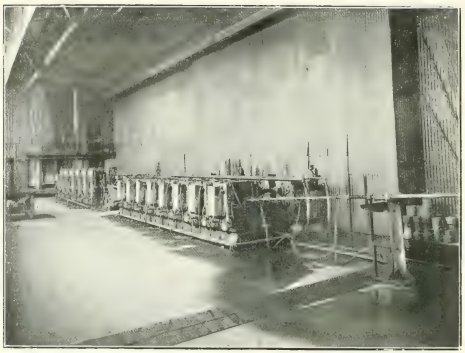


FIG. 8. MORGAN CONTINUOUS ROD MILL. FINISHING END.

roller bearings, and so placed that only three wheels at one time can touch the floor, are placed at the end of the conveyor. The truck, shown by fig. 10, is designed for a load of one ton of rods, a quantity which can be handled by one man. As the coil leaves the end of the conveyor, it drops in an upright position on to the body of the waiting wire truck (fig. 11). One coil after another is thus automatically deposited on the truck, until the same is filled with rod coils standing almost vertically side by side. These coils are now rapidly inspected and conveyed into the cleaning house, where they are pickled, cleaned, and dried ready for the wire drawing mill.

According to personal observations repeatedly made during my trip, the time which it requires for the entire billet to pass through the mill, from the moment it enters the first pass till the 300 lb. coil of rods slides on to the conveyor, averages fifty-eight seconds. The time from the moment when the billet enters the first roughing pass until it begins to coil itself on the reel is sixteen seconds. Only $\frac{1}{16}$ of the billet are, therefore, at any one moment actually in the rolls, and at the time when the rod reaches the reel, $\frac{12}{16}$ of the billet yet remains in the furnace. It is thus readily understood, that as more than two-thirds of the billet are until its temperature is reduced below the point where oxidation takes place.

The guiding pipe is arranged as a switch which may convey the rod to either of two Automatic Morgan Laying Reels. This ingenious machine is shown by fig. 9. It consists of a bedplate sloping at an angle of about 40 degrees to the horizontal. Protruding above this plate is a stationary centre which can be lowered by a steam cylinder below the face of the plate. In a frame resting above the plate is supported a revolving inclined radial arm or conduit, through the hollow centre of which the rod passes after leaving the cooling pipe. As the rod is issuing from the revolving arm, it falls on the plate and is coiled, much as a sailor coils a rope, around the stationary centre extending above the sloping bedplate. The two reels are kept continually revolving. When one rod, which from a 300-lb. billet will reach a length of more than one half mile, is coiled around reel No. 1, the switch tube is placed in communication with reel No. 2, on which the next rod, which swiftly follows the previous one, is in its order being coiled. In the meantime, the centre of reel No. 1 is lowered below the face of the sloping plate. The coil of rods, thus liberated, slides gently down the sloping face, and lands without shock on the stationary floor of the rod conveyor. In slots between the plates forming the floor of this conveyor run endless link chains from which prongs protrude, which extend above the floor of the conveyor. The hot coil of rods is gripped by two [illegible] carried up the inclined plane [illegible] out of the [illegible] into the yard of the cleaning house.

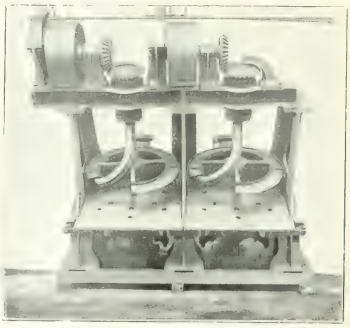


FIG. 9. STATIONARY LAYING REEL.

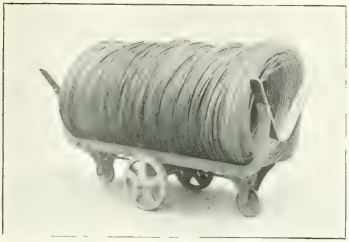


FIG. 10. WIRE TRUCK LOADER.

either in the furnace or on the reel, he could be most destroy more than one-third of the billet. If, as sometimes will happen in any mill, a mishap should occur during the rolling, the roller immediately drops a chisel-like shear attached to the first housings on to the billet in front of the first roughing pass, and at the same time the ½-in. billet is instantly cut by the flying shear between the two trains. The portion of the billet in the mill is, therefore, run out partly as ½-in. square rod, which is easily handled and may be merchantable, and partly No. 5 wire rod. The remaining portion of the billet is brought back into the furnace, and is ready to be rolled when the cause of the mishap has been removed.

It has been found in practice that the uniform heat treatment made possible by the continuous rolling keeps the rods considerably softer than those rolled on Belgian mills, where the first end is run out hot, while the last end is finished at the lowest practicable temperature. This limits the length of rod produced by the Belgian mill. In the continuous mill, on the other hand, there is no technical difficulty in rolling rods of any length; but the 300-lb. billet has been found a practical size and is, therefore, at present considered as a standard.

Wire rods are a half-finished product. They are seldom used as such, but constitute the raw material for wire. What is required of the rod mill is, therefore, to produce a rod which lends itself for wire drawing without unduly wearing the dies. The continuous mill in which each pass is independent, and which may be watched and adjusted during the process of rolling, lends itself admirably to the production of wire rods.

Irregularity in section may in any mill be due to three causes:—

(1) Irregular heating, due to the shortcomings of the heater.

(2) Irregular rolling, due to incompetence of the roller.

(3) Faulty adjustment of machinery.

The first and second of these are local causes, the responsibility for which devolves on the management. The third defect has, in the continuous mill, been as much as possible eliminated by nearly perfect design and workmanship of the mill, and by well-built and practical devices for adjustment and control. If, however, a certain irregularity should occur in a continuous mill, the injurious effect of the same is largely eliminated by the action of the laying reel. For every time the radial arm revolves, the rod must of necessity be twisted one turn. The irregularities are, therefore, distributed around the surface of the rod as a slow spiral. Instead of wearing the die at one side only, the wear will, therefore, be distributed regularly around the entire circumference. It has been found possible to draw a No. 5 rod rolled by the continuous process two gauges finer, without annealing, than a similar rod rolled in ordinary Belgian mills.

The continuous rod mill has an average capacity of 160 tons of No. 5 rods per twenty-four hours, when running one rod at a time. If desired, two rods may be rolled simultaneously without other change in the mill than an increase in the number of reels, engine and boiler power.

At the Sharon Steel Company's works, two continuous rod mills, placed side by side, produce, when regularly supplied with steel, over 500 tons of rods per day.

In labour, the mill is strikingly economical. The total force employed for a one-strand rod mill, that

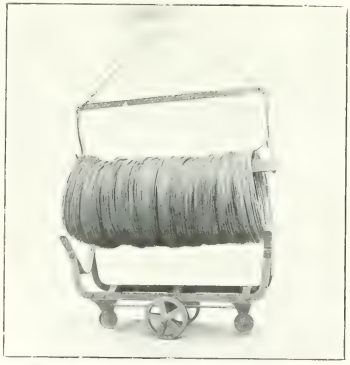


FIG. 11. WIRE TRUCK, SHOWING METHOD OF HANDLING WIRE COILS.



FIG. 6. WICKWIRE BROS', ROD MILL, CORTLANDS, N.Y. EXTERIOR VIEW

is 11 producing 160 tons per twenty four hours is —

Occupation	Number of Men Day.	Night.	24 Hours
Roller	1		1
Roller's assistant	...	1	1
Heater	1	1	2
Heater's assistant ...	1	1	2
Charger	1	1	2
Charger's assistant	1	1	2
Feeder	1	1	2
Rougher	1	1	2
Shear boy ...	1	1	2
Finisher... ...	1	1	2
Roll pipe switch boy	1	1	2
Conveyor man	2	2	4
Ash and coal wheeler	1	1	2
Engineer	1	1	2
Oiler	1	1	2
Scrapman and sweeper	1	1	2
Scrap boy cuts mined ends	1	1	2
Craneman	1	1	2
Coal and ash wheeler	½	½	1
Hookman	½	½	1
Millwright	1		1
Belt hand	1		1
Fireman	2	2	4
Weighmaster	1	1	2
Total men and boys	24	22	46

[illegible] on the mill only two the heater [illegible] to be skilled men. Many of the [illegible] to advantage be filled by boys [illegible] is probable that the more work the [illegible] the more regularly it operates.

the less work there is to be done. For that reason, the men are thoroughly in favour of keeping the mills in good condition and of watching all details.

The roll turning for a continuous mill producing 160 tons per day is performed by one man working single turn. The entire equipment required consists of one roll lathe proper, and one machine lathe for dressing roll necks.

Costs and economies are local questions, depending on price of fuel, price of labour, cost of steel billets, and, not the least, skill, intelligence and attention of operators and management. The continuous rod mill will, with good stock, produce close to 97 per cent of rods from 1¾-in. billets.

The entire modern rod mill plant is contained in a building 75 ft. to 80 ft. wide and 200 ft. to 220 ft. long (fig. 6). At the upper end of this building is placed the billet storage. Below this follows the continuous furnace with its accessories. The gas producers are often placed under a separate shed, built alongside the mill building and adjacent to the furnace. At the lower side of the furnace follows the roughing train, flying shear, and finishing train. About 50 ft. away from the finishing pass, near the lower end of the building, are located the reels and the rod conveyor, the far end of which extends outside of the building into the inspection yard or cleaning house. Opposite the train is placed the gearing, belt drive and engine, together with pumps, air compressor, condenser, and feed water heater. At the lower end of the building opposite the reels, is placed the boiler plant, which generally consists of 800 nominal h.p. of water-tube or cylindrical return flue boilers. The billet storage is sometimes covered by a light travelling crane. Over the mill and reels is suspended a small pneumatic crane of sufficient power to lift two rolls.

The cost of a complete plant in the United States may vary, according to location, completeness and time of construction from £30,000 to £40,000. It has in every case proved a sound and very profitable investment.

HOOP MILL.

The wire rod train may be used for rolling hoops and cotton ties. The latter are ⅝ in. wide by No. 19 wire gauge thick. They are rolled from the ordinary 1¾-in. billet. Only four stands of the finishing train are used. When the band leaves the last of these four stands it is still at a high temperature, and as delicate as wet paper. It is now run through an oscillating distributor, which deposits the element band in regular loops on wire-

on a slowly moving conveyor or apron shown by fig. 12, on which the loops are standing, so that the broad sides of the cotton tie may cool without contact with other metal. This treatment ensures the beautiful, glossy blue oxide finish, which is considered desirable, especially for hoop. When the band has slightly cooled, it is wound up into solid coils, which are placed on a reel and fed through a continuous revolving shear, where they are cut into required lengths of about 11 ft. 6 in. if cotton tie, or any desired shorter lengths for hoops. A number of ties are then packed into a bundle and buckled together by means of clamps made from scrap tie. Cotton tie bundles are then dipped into a vat, coated with a tar composition, and leave the mill building ready for shipment.

I pass this form of mill with a brief mention, chiefly because England is not a cotton producing country, and because we could hardly expect to compete with the protected hoop and tie mills in America in furnishing this product to the planters of the South. The mill is, therefore, of little direct interest to us.

OTHER USES FOR THE STANDARD CONTINUOUS WIRE ROD MILL.

These mills have successfully produced small rounds and squares in merchantable sizes. Thus, a rod mill at the Joliet Works of the Illinois Steel Company is regularly rolling spike bars, which are converted into railroad spikes. The last four stands of the finishing train are for this purpose removed and replaced by a flying shear and a hot bed, on which the spike bars are assembled, and whence they are conveyed to the adjacent cooling bed.

THE MERCHANT MILL.

The great waste of material in the manufacture of merchant bars rolled on ordinary three-high rolling mills, and in short lengths, has, during the last three years, caused the construction in the United States of special merchant mills, in which bars are rolled in long lengths and cut up to fill orders or stored entirely, so that small orders of standard sections can be cut immediately, and shipped from the stock on hand, without unnecessary waste of good and ready material in short bars or crop ends.

The first of these mills was installed at the works of Messrs. Jones and Laughlins, Ltd., of Pittsburg. Later, other makers have built similar mills, and the greatest perfection in plant has finally been reached in the magnificent merchant bar mills at the Duquesne Works of the Carnegie Steel Company. An idea of the mill will best be conveyed by a description of this plant.

The two mills, fig. 13 (10-in. and 13-in.), are contained in one steel building 800 ft. long, with a single span of 200 ft. Beyond, and at one end of this building, is placed a boiler house covering twelve Babcock and Wilcox boilers, with a combined capacity of 3,000 h.p. The boilers are fitted with coal pockets, elevators, and distributors, mechanical stokers and ash conveyors and the whole is a good specimen of an up-to-date boiler plant.

The 10-in. mill is used for sections from $\frac{3}{8}$-in. up to $\frac{5}{8}$-in. squares or rounds, and equivalents in flats. The larger 13-in. mill will roll rounds up to $2\frac{1}{16}$-in. squares and equivalents, and has also successfully rolled 2-in. by 2-in., $2\frac{1}{2}$-in. by $2\frac{1}{2}$-in., and 3-in. by 3-in. angles, from $\frac{7}{16}$-in. to $\frac{9}{16}$-in. in thickness.

THE 10-INCH MERCHANT MILL.

Has roughing stand with $12\frac{1}{2}$-in. rolls, and 2-in. square billets, in 30 ft. lengths; the size used depending on the section of the finished bar. They are transported from the billet department, located at a distance of nearly one half-mile from the bar mills, to the billet storage, which runs the entire width of the building, and is commanded by an overhead travelling crane. The billets are fed into a Morgan continuous furnace of the ordinary size, and leave this furnace to pass through a roughing train of four pairs of continuous rolls. The bar is then run through six passes of a six-speed finishing train, of an entirely novel construction. It consists of six stands of two-high "bull heads," each pair of rolls having its own pair of pinions. They are driven in pairs from three pick shafts running at different



FIG. 12. CONTINUOUS HOOP MILL—FALL CONVEYOR.

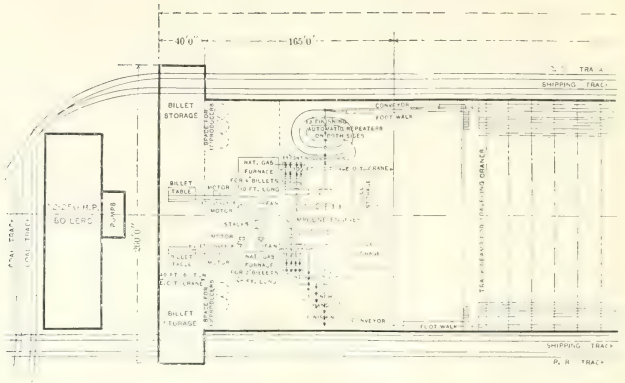


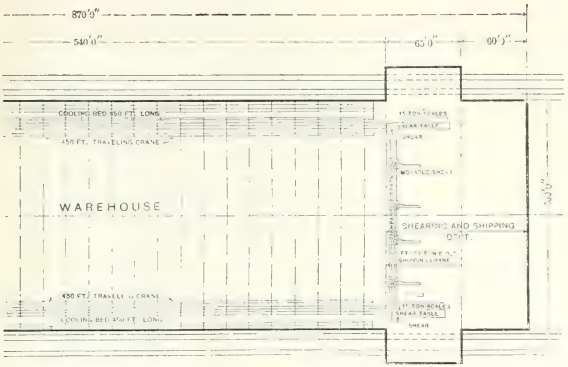
FIG. 13. GENERAL PLAN OF MERCHANT

speeds. The jack shaft drives the nearest pair of pinions and rolls through the upper pinion. The nearest upper roll connects with the bottom pinion of the second pair. This construction permits of the first rolls on each shaft being made as much smaller than the second pair as may be desired. The object aimed at is construction of a mill in which, under average conditions, each pass is operative approximately the same number of seconds. In other words, the action of the mill is such that if the billet leaves the furnace equally heated, each foot of its entire length will receive almost exactly the same amount of cooling between the furnace and the finishing pass. The heater's orders are to so adjust his furnace by means of the fourteen gas and air valves, that the temperature at the finishing pass shall be uniform. Thus the section of the finished bar is kept uniform from end to end, instead of the last end being larger than the first, as is so common in ordinary bar mills. The sections being frequently changed, automatic repeaters are not advisable. One man is placed at each of the six bull-head passes to enter the bar. The mill is run by a 1,200 h.p. compound condensing engine. The roughing rolls are driven by spur gears, the finishing trams by

On leaving the finishing pass, the bar runs through a pipe to a pair of pinching feed rollers which carry it to the top of an Edwards' automatic gravity cooling bed. The top of the bed, along which the newly-rolled bar travels, is fitted with conical rollers, about 10 in. diameter at the base and 12 in. long. Their axes are placed at such an incline that the top side is horizontal. These rollers are

so that they may be pointed about 5 degrees away from the mill, or the same angle towards the mill. The rollers are supported on, and driven by, an endless electrically operated $\frac{3}{4}$ in. wire rope, which passes under them near their base, and is in turn supported by intermediate carrying sheaves. If the conical rollers are pointed away from the mill, the bar which is being run out immediately works towards the base of the rollers. If, on the other hand, the rollers are pointed towards the mill, the bar will leave the base and travel towards the point of rollers. On reaching a point about $2\frac{1}{2}$ in. from the apex of the cones, the bar slips over an off-set in the surface of the same, and once outside this off-set, it cannot return again towards the base, however the rollers may be pointed.

The slope of the cooling bed is formed of cast-iron escapement bars, or ladders, resting, top and bottom, in sockets or open bearings. These bars are cast with horns, or prongs, placed alternately at 150 degrees angle, a distance of 3 in. from one another. By an arm extending downward from the cast-iron bar in a direction opposite to the line bisecting the angle between the prongs, the escapement bar may be rocked forward and back through an angle of 40 degrees. In one extreme position the right hand prongs extend above the plane of the bed; in the other extreme position, the left hand arms protrude. These escapement bars are placed at a distance of 21 in. centre to centre along the entire length of the 450 ft. cooling bed. In the spaces between each ladder are placed two plain rails in such position that all the supports, whether plain or pronged, will form one inclined plane down which the bars will travel while being cooled.



MILLS AT DUQUESNE STEEL WORKS.

projection extends backward so far, that a bar resting on the pointed rollers between the off-set and the apex is within reach of these wings. All the ladders are moved forward and back simultaneously by one wire rope, clamped to each rocker arm and worked by a steam cylinder. By turning the ladders so that the wings which are pointing away from the mill are lifted above the plane of the cooling bed, the bar is lifted off the rollers and slid on to the first or top prongs of the ladders. If the piston in the cylinder makes a second stroke, reversing ladders, this same bar will drop to the second line of prongs. Another reversal will bring it into the third line, and so on until the bar has reached the end of the ladder and is delivered on to horizontal sliding bars at the foot of the cooling bed. If a new bar is delivered on to the conical rollers, before each reversal of the ladders, every line of prongs will be made to carry a bar and the gravity bed will be kept filled with gradually cooling steel. As soon as a batch of from eight to twenty bars have been gathered on to the assembling platform at the foot of the bed, they are pushed on to the adjacent delivery rollers to the shear by a number of horizontal push bars, sliding on to the rails which support the rolled bars, and actuated by levers keyed to one shaft which runs the entire length of the cooling bed, and which is oscillated by a steam cylinder. The delivery rollers convey the entire batch of bars to the shears, where the first end is cut off. The bars are then run up against the adjustable stop behind the shears and simultaneously cut into lengths as specified. As each batch is cut, it is pushed on to the weighbridge, fig. 15, which supports "U" shaped cast-iron cradles into which the cut bars are dropped. Two chain slings are placed around the bundle of bars, which is lifted by an electric crane. If for immediate shipment, two light hoops of round steel are twisted round the bars while they are hanging in the chains. They are then placed on railway cars, the chain slings are detached, and the bundle, which may weigh fifteen tons, is ready to leave the mill. I have frequently seen an entire fifty-ton car load made up of three bundles of merchant bar.

The 10-in. mill described above, rolled in January, 1903, in twenty-four hours, 433 gross tons of ¾-in. round rivet bars.

The number of men employed per twenty-four hours, for operating this mill, as well as the 13-in. mill, which forms part of the plant, is given below :—

MEN ON CARNEGIE DOUBLE STORAGE MILLS PER SHIFT

Stockman	1	1
Billet crane boy	1	1
" chainmaker	1	1
Furnace charger	1	1
" helper	2	2
Furnace bucket	1	1
" helper	1	1
Mill roller	1	1
Rougher	1	1
Roller	1	1
" helper	1	1
Finishers	6	6
Spell hands	2	2
Helpers		2
Scrap men	2	2
Mill crane boy	1	

	10-in. Mill	13-in. Mill
Cooling bed	4	4
Inspector	1	1
Shear men	1	1
" helper	2	2
Shipping crane ...	½	½
" chain men	1	1
Electrician	½	½
Millwright	½	½
" helpers	1	1
Engineers..	½	½
" helper... ...	½	½
" greaser	½	½
Mill greaser	½	½
Furnace "	½	½
Coal machine	½	½
Water tender	½	½
Ash machine	½	½
Bundlers	2	2
Total men and boys per 24 hours	30	41

13-INCH MERCHANT MILL.

For this mill, 30-ft. billets, from 2½ in. up to 4 in. square, are used. They are heated in a standard Morgan continuous furnace and passed through a continuous roughing mill of four passes. Thence this bar travels through curved repeater guides placed at different levels in the floor, turning angles of 180 degrees, and entering consecutively and automatically into the six passes of the finishing train, which is of novel design. It consists of a train of three stands of two-high "bull-heads," driven by one stand of pinions, beyond which, and running in the opposite direction, are three other stands of two-high "bull-heads" with their stand of pinions. Automatic repeaters are used on both sides of the mill. The Morgan merchant mills [illegible] the first and only successful arrangement of such automatic repeaters. The secret of their success lies in the spread-out arrangement of the roll stands, which makes it possible to give extra large radii to the repeater grooves.

The bar leaves this train to pass through a pipe guide, which, with the aid of pinching [illegible] through some [illegible] than for the 10-in. mill described above. The processes of cooling, gathering, shearing, bundling and shipping the bars are the same as those described for the 10-in. mill. The mill is [illegible] pound condensing engine, the roughing train by gearing, the finishing passes by belt drive.

The capacity of the mill is from 400 to 600 tons per twenty-four hours.

STORAGE SYSTEM.

During the year that these Carnegie mills have been in operation, the demand for all steel products has been so enormous in the United States that there has never been an opportunity to accumulate a stock of merchant bars. Orders have always been ahead of the producing capacity. The bar storage has, therefore, not yet been completed.

The description which I give below of this system, which, especially for Great Britain, where orders are generally received for small quantities of bars of varying lengths and different sections, should be most interesting and important, refers to the arrangement in the mills of Jones and Laughlin's, Ltd., Pittsburg, Pa. The cooling beds in this plant are 300 ft. long for the 13-in. and 350 ft. long for the 10-in. mill. The floor space between the mills is taken up by pockets formed by lines of "U" shaped stands spaced about 5 ft. centre to centre, and extending the entire length of the cooling beds. These stands are formed by double bars of 3½-in. by ¾-in. steel, and are about 5 ft. high. They are coupled and braced by 3-in. by 3-in. angles placed "A" fashion over the top of the "U's."

Over these pockets and over the delivery rollers to the shear runs a 350 ft. long broadside crane. The body of this crane consists of two 10-in. channels, held together by distance pieces, and spliced to a length of 350 ft. This girder is suspended from wheels running on the channels which form the bottom chords of the roof trusses of the building. A shaft parallel with the crane,



13-IN. CONTINUOUS BAR MILL, JONES & LAUGHLIN STEEL WORKS.

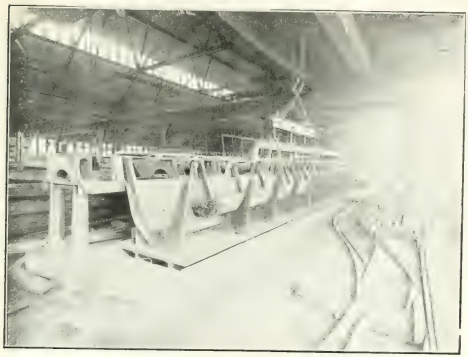


FIG. 15. BAR-SHEAR, WEIGHBRIDGE, AND BUNDLING ARRANGEMENTS.

cooling beds and pockets, carries a number of sheaves, over which pass endless wire ropes attached to the crane. The shaft is driven by an electric motor. By nicely adjusting the ropes, the flexible crane, 350 ft. long, can be moved from one side of the building to the other, while kept in alignment to within 1 in. of a straight line. Under the crane body is suspended a lighter girder of 5-in. channels tied together by distance pieces and splice plates. This is carried by chains spaced about 10 ft., and running over sheaves resting on the main frame of the crane. The upper ends of all these chains are bolted to one longitudinal bar, which may be moved forward or back by a pneumatic cylinder. When the bar is moved backward, the lower 5-in. channel frame is lifted. When the bar is advanced, it is lowered. The stroke is about 6 ft., or sufficient for lowering the 5-in. girder almost to the bottom of the pockets. Spaced about 5 ft. apart, and suspended from this lower frame, are hooks which may be simultaneously opened or closed by an endless wire rope, worked by a pneumatic cylinder. An operating platform is placed at the middle of the crane, whence the transverse motion, the hoisting, and the opening and closing of the hooks can be directed by one man. When it is intended to store a quantity of bars being rolled, the crane is placed over the bars gathered on the delivery rollers to the shears. The hooks of the lower frame are opened. The frame is lowered over the bars until they are well within the hooks. The hooks are now closed under them, and the lower frame carrying the bars is raised, until the latter are lifted sufficiently high to clear the delivery rollers and pass over the top of the storage pockets. The crane is then moved transversely until it reaches a position directly over the pocket into which the bars are to be deposited. The 5-in. frame is now lowered until the bars are a short distance above the bottom of the pocket, when the hooks are opened and the bars are permitted to drop in to the "U's."

At the lower end of the storage pockets are placed travelling electric shears (fig. 16), running on a traverse track. When an order for odd bars is to be filled from stock, a pair of tongs is fastened to one of the 350-ft., or shorter, bars of the specified section resting in the storage pocket. By means of a rope attached to the tongs and a nigger-head extending from one of the gear shafts of the shear, the desired bar is dragged from the pocket and entered into a pair of pinching feed rollers which feed it through the knives of the shear. The last end is now cropped and the bar is again

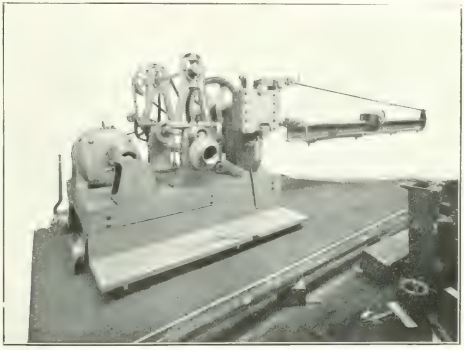


FIG. 16. TRAVELLING SHEAR FOR CUTTING FROM STORAGE.

advanced until it strikes the adjustable stop behind the shear, when it is cut to desired length. Merchant bars of varying length may therefore be cut from one long bar without unnecessary waste of good stock the only loss in the 350 ft. bar being one short crop end, and, possibly one "short" at the rear end of the bar.

The storage system is, as explained, a successful solution of the problem of manufacturing bars in such a manner that small and varied orders for ordinary sizes may at all times be filled promptly and with minimum waste. During the years of my practical experience, I have a great many times been crippled and held back by the impossibility of quickly obtaining merchant bar, and would, if I had known where to secure prompt delivery, unquestionably have gone to the maker who could guarantee it. Nothing has been more usual than to have it explained when placing an order, that as the quantity wanted was so small, the manufacturer could not afford to change rolls in order to make the bars required, but must ask his customers to be patient until sufficient orders for the same sections had accumulated to justify him in making the roll change. A moderate sized billet storage makes it practicable, and economical, to store standard sections of bars for the immediate execution of small and urgent orders.

An installation such as that of the Carnegie Steel Company would probably cost as much as £200,000. It is, however, not necessary to build so large or complete a plant, or to go so far in the rolling of long lengths, which require corresponding buildings, cooling beds, and spare storage.

The Deering-Harvester Company, of Chicago, who for their enormous output of agricultural machinery, require eighty different sections of squares, rounds, flats, channels, zeds, ovals, half-rounds, crosses, and angles, are now building a merchant mill which will be capable of rolling sections covering over 75 per cent. of their tonnage.

This mill, which consists of a 14-in. roughing train of eight continuous stands, and the usual six bull heads, will have a cooling bed 250 ft. long. It will be driven by an engine of 1,200 h.p. The billets will be heated in Morgan continuous discharge furnaces, slightly modified from those previously described. The entire plant, except the cooling bed and boilers, is covered by a building 80 ft. wide by 360 ft. long. This plant will probably cost less than one-third of the sum expended for the double storage Carnegie mill.

The effect of these new merchant mills on the older bar mills in the United States will be disastrous when the present demand and large margin of profit is reduced. By the new system bars can be produced at but little more than half the cost of the older mills. The stiff, well made, and easily adjustable mills maintain better and more correct sections, roll lengths heretofore considered impossible, and the entire length of bar makes the finishing pass at a uniform temperature. The steel, uniformly treated and cooled on the gravity cooling beds, is more uniform than steel of the same composition rolled on the old mills. The great capacity of the mills, and the stock kept on hand, enable their owners to supply customers more promptly. As a consequence, the bar business in the United States is more and more gravitating into the hands of a few large and well-equipped manufacturers. The public is unquestionably a gainer by the change, though the older and less fully equipped mills suffer.

The continuous mill as an invention is, as above stated, old. Anybody may build a continuous mill who is willing to pay for his experience. What has kept the modern continuous mill a speciality of one firm is the amount of valuable experience acquired during years of work, and the many specially designed accessories which go to make the continuous mill plant into an organised unit. It is not easy or profitable for general engineers and builders to enter the field where so much experience and knowledge of the minutest details is requisite for the achievement of success. Thus it is that the Morgan Construction Company, led by the man who made the continuous mill what it is to-day, still remains alone in the field. Certain other firms build partly continuous roll trains, and make arrangements with the Morgan Construction Company, by which they secure the right to use their specialities. But still it is the Morgan mill, and the Morgan system, which to-day alone represents the highest achievements of economy and technical success in the field of continuous rolling of billets, rods and light merchant sections.



HIGH CAPACITY WAGONS.

BY

"ONE WHO DOES NOT NEGLECT THE LOGIC OF FACTS."

THE question of the use of high capacity wagons on British railways is at the present engaging the attention of railway managers to a considerable extent, and is also of special importance to many large private owners, more particularly firms who consign material in considerable bulk, but I do not think that the contribution by your correspondent in your May issue will much assist towards the settlement of the question, as that gentleman appears to ignore the logic of facts.

Your correspondent states that these wagons cannot be used for shipping purposes, but a considerable number of wagons are now in use by the North-Eastern Railway Company for their coal traffic to Tyne Dock, over drops approximately 14 ft. 6 in. by 4 ft. 3 in. These wagons are of 40-tons capacity, and were built to discharge the full load through this space under 40 seconds, so that no alterations are necessary where wagons have not to be lifted. Of course where wagons have to be lifted, as is the case at many of our ports, the conditions are altered, but I do not for a moment regard this as an insuperable barrier to their use for shipping traffic.

As to the statement that with the doors between the bogies, 30-ton wagons can only discharge one-third their contents, it should be understood that the whole of the contents can easily be discharged through doors fixed between the bogies ; and this is the case with the North-Eastern wagons above referred to.

In my opinion there would be no difficulty in the loading of this type of wagon, even with increased height of sides (which is anticipated by the present Clearing House rules, allowing wagons to be built 10 ft. from rails), as there are a few collieries in this country with height of screens that would accommodate them, and in view of the advantages which colliery owners would undoubtedly derive from their use there is no doubt they would readily adapt their appliances to suit. Wagons are now being built for the Central South African Railways, of 80,000 lb. capacity, 3-ft. 6-in. gauge, and these will discharge the whole of the contents by longitudinal doors between the bogies, either inside or outside the rails ; and if our colonial friends can efficiently use the wagons in this way, surely British railway managers should find no difficulty in doing so.

One railway in America within the last two years put aside 15,000 small wagons at one time, and replaced them by high capacity wagons, on account of the superior economy and other advantages of the latter.

As to their use for general merchandise, I may say that a number of 30-ton wagons are used for this service by the Caledonian Railway Company for express goods with complete success, which, I venture to think, disposes of the contention that these wagons are not suitable for general goods traffic in this country, all that is required to make them successful in this respect being a through consignment from point to point. Of course, where merchandise is consigned in small lots the smaller capacity wagon is preferable, but for such traffic as sugar, grain, coal and all mineral traffic generally I believe the high capacity wagon is the best, as there is not only a substantial saving in the tare weight of such wagons, averaging, I am told, from 30 to 40 per cent., but there is also a saving in train length of from 35 to 50 per cent., with a corresponding saving in the siding accommodation necessary for such traffic. These wagons are all fitted with the Vacuum or Westinghouse brake, with the direct object of being run as express goods.

With regard to the question of collision, the writer has never heard that any outcry took place when a collision occurred with passenger coaches that the line was blocked on account of the *length* of the vehicles, and carriages are used in this country up to 60 ft. over headstocks, whereas the length of an ordinary 30-ton or 40-ton wagon will not exceed, say, 40 ft.

Reference is made to the "enormous cost of repairs," but this, I think, only exists in the imagination of your correspondent, these wagons having proved that the cost of repairs is a *quantité négligé*. One case occurred within the knowledge of the writer where a wagon constructed to carry 70,000 lb. on a 3-ft. 6-in. gauge, recently went down an embankment. It was hauled up and put on its bogies and went into traffic without repairs.

As to the opinion that there are no better wagons suited for use in this country than the present oak underframe and deal body wagons, for certain classes of traffic, this may be true, but the fact that the North-Eastern, Midland, Caledonian and other railway companies are introducing on their systems high capacity steel wagons tends to show that the opinion expressed by your correspondent is not shared by them.

It has been proved over and over again that in collisions, where timber wagons have had to be burned on the spot as the most economical means of clearing them out of the way, they being absolutely beyond repair, steel wagons have been put into traffic in a very short time, with very slight repairs.

In discussing this question we must not overlook the position of the railway companies in regard to a great many small merchants, who use the wagons as a warehouse, taking the full time allowed for unloading, and, by ordering in sequence, make profitable use of the wagons, to themselves. Probably the railway companies might not allow them to keep, say, a 30-ton wagon three times as long as they keep a 10-ton wagon.

I believe the Railway Clearing House specification for private owners' wagons does not limit them to any tare weight at the present time, and were they to make a move in this direction, and could the various companies see their way to give the traders some advantage in rates for goods carried in high capacity wagons having a low ratio of tare weight to paying load, we should see in a very short time the general adoption of steel wagons by all classes of traders. This seems to me to be the line of progress at the present time, and it is certainly satisfactory to see that the question is engaging the earnest attention of our railways.

PAGE'S MAGAZINE

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OUR MONTHLY RÉSUMÉ.

LONDON, May 20th, 1903.

The Labour Crisis.

The sudden outbreak in May of a labour dispute with the engineers has seriously disturbed the shipbuilding industry since our last comments. Contrary to expectation, the members of the A.S.E. in the North-east and the North-west districts (briefly, the areas of the Tyne and Clyde) refused to accept the recommendations of the Conference of Executive Councils, which met in London in March. These recommendations were, that in the North-east district a reduction of wages should be made of 1s. per week in time rates and 2½ per cent. in piece rates; that in the North-west district the reduction should be 1s. per week, or ¼d. an hour in time rates, and 5 per cent. in piece rates; that the North-west employers should give some consideration to the special case of the employees in Johnstone and Motherwell, where the rates were lower than elsewhere; and that the new rates should come into effect on the 1st May and hold good for six months. These recommendations of the Conference were framed on the proposals made by the delegates of the Allied Trade Unions. The employers accepted them, and in Scotland gave the Johnstone and Motherwell employees the concession of the right to apply for a modification in one month, instead of six months. The steam engine makers also accepted the recommendation. But the A.S.E. men rejected them by ballot, and in a second ballot declared in favour of a strike rather than give way. Consequently, they did not resume work at all on 1st May in the upper portions of the Clyde district, and they only went to work in the North-east coast ports on the condition that another Conference would be held immediately with the employers to reconsider the situation. The employers, while ready to confer, could not hold conference with men on strike. And they could not withdraw the reduction without breach of faith with all the other workers in the shipyards, who accepted the reduction on the assurance that it would be similar in all branches of shipbuilding labour in order to promote a revival of the industry. But they were willing, on the appeal of the officials of the A.S.E., to limit the period of reduction to three months, at the end of which term the question can be reconsidered.

Shipping Outlook.

This labour crisis was extremely unfortunate at this juncture, for the Admiralty contracts are about to be placed under the new programme, and they will not be placed where there is any likelihood of delay on account of labour disputes. The delays caused by the 1897-8

strike are not forgotten, and if the engineering dispute is prolonged the Admiralty orders will probably be diverted to the dockyards. And the shipyards are badly enough off for contracts, notwithstanding the few orders placed in the North of England in April. In Scotland the output that month was twenty-one vessels of 34,420 tons, as compared with twenty-eight vessels of 46,660 tons in the corresponding month; and the new orders booked by Scotch shipbuilders did not exceed 31,000 tons—nearly all liners and craft for special purposes.

According to Lloyd's returns there were at the beginning of the second quarter of the year, under construction in the United Kingdom 382 merchant steamers of 663,305 tons, and 43 merchant sailers of 11,321 tons. This is a total of 425 merchant vessels of 674,686 tons, as compared with 431 vessels and 1,240,344 tons at the corresponding period. This is a very material reduction, which ought to have its lesson on the men. As pig iron is falling shipbuilding material should now decline, and there would be some hope of witnessing a revival in the demand for new ships before the end of the year if the engineers were not so combative, and so rebellious to their own trade union.

American Shipbuilding.

With regard to shipbuilding in America, Mr. Eugene Chamberlain, the chief of the American Bureau of Navigation, reports that 79 vessels of 31,448 gross tons were officially numbered during March. The bulk of the steel steam tonnage was contributed by yards on the Great Lakes, but the largest vessel—the *Mississippi*, of 8,100 tons, for the Atlantic Transport Company—was built at Camden, N.J. For the quarter the total was 187 vessels of 58,588 tons, as compared with 232 vessels of 90,995 tons in the corresponding period of last year. The decrease was chiefly due to declines in Atlantic and Gulf and Great Lakes ports. The aggregate for the nine months of the financial year is 814 vessels of 230,187 tons, as compared with 949 vessels of 245,068 tons in 1901-2. The contribution of Atlantic and Gulf ports was 124,569 tons, against 131,900 tons last year; of Pacific ports, 33,015 tons, against 28,778 tons; and of ports on the Great Lakes, 65,367 tons, against 78,004 tons. Although there was a decrease in the total tonnage officially numbered, there was an increase in the number of steel steamers produced of nearly 4,000 tons.

New Cunard Development.

The new Cunard steamer, *Carpathia*, built by Messrs. C. S. Swan and Hunter, Ltd., and engined by the Wallsend Shipway and Engineering Company, Ltd., is a new departure for the Cunard Company, and one pointing to further developments in the Atlantic service. All the leading ocean-going passenger steamers have hitherto had first, second, and third class accommodation, but in the *Carpathia* the very high-class accommodation is dropped, and the whole vessel is devoted to second and third class cabins and saloons. The abolition of the first-class cabins allows the second to be placed in the best possible positions, and the third to be distributed all over the vessel, an arrangement which adds greatly to the comfort of the passengers. The fittings are better than the average second and third class, and a considerable improvement even on those of the *Ivernia* and *Saxonia*. The new provision is for those travellers by whom the maximum of comfort is preferred to the greatest possible speed. A vessel such as the *Carpathia* appeals strongly to the ever-increasing number of passengers who are always travelling between Europe and America, and who have in the past gone second and third class on ordinary liners. The *Carpathia* is a seven-and-a-half days' boat, requiring half a day more for the run than the *Ivernia* or the *Saxonia*. She is a twin-screw steamer, 570 ft. in length over all, 64 ft. 3 in. in breadth, and 40 ft. 6 in. in depth. She measures 13,555 tons gross, 24,000 tons displacement, when fully loaded, 12,500 tons deadweight, and has engines of 9,000 i.h.p., capable of giving a speed of 14½ knots. The cabin passengers, of whom over 200 can be carried, are berthed on the bridge and shelter decks. The approaches to the saloon and to all the cabins are so spacious that congestion is impossible, and everything has been done to make the accommodation roomy and comfortable, and the attendance and dietary as perfect as possible.

The accommodation provided for third class passengers offers a remarkable contrast to that customary on liners of even recent date. The *Carpathia* will accommodate 1,700 of this class berthed on the upper and main decks. The ship is splendidly ventilated throughout, and very special attention has been given to the sanitary arrangements. The engines are of the most improved type. They are quadruple expansion, with cylinders 26 in., 37 in., 53 in., and 76 in. diameter respectively, and having a stroke of 54 in. The first three cylinders have piston valves and the low-pressure cylinder has an ordinary double-ported slide valve. There are seven boilers, all single-ended, to work at a pressure of 210 lb. They are all arranged in one boiler-room, with two stokeholds. The propellers are of manganese bronze, with cast-iron bosses, and have each three blades; and the funnel is of large diameter, with an outer air casing carried to the top, 130 ft. from the keel.

The Iron and Steel Institute.

The Iron and Steel Institute had its Spring Meeting on May 7th and 8th, at the house of the Institution of Civil Engineers, and taxed those capacious rooms to the utmost to accommodate the unusually large assemblage of members and visitors; in fact the Institute is pursuing its useful course energetically, and is flourishing numerically and financially. The report of the Council, read by the secretary, Mr. Bennett H. Brough, showed that during the year 1902 no less than 123 names had been added to the register.

Awards.

Mr. Andrew Carnegie's first action, as the new President, was the presentation of medals, the Bessemer Medal to Sir James Kitson, the Carnegie Gold Medal to Mr. A. Campion (London), a special Carnegie Silver Medal to Dr. O. Boudouard (Paris). The last two with P. Longmuir (Sheffield), and E. Schott (Berlin), are four out of the six Andrew Carnegie Research Scholars who have completed their work, but Messrs. Campion and Longmuir were awarded £50 each to continue their work, and four new Carnegie Scholarships were awarded. The President then delivered his address, which will be found in another part of the magazine.

Continuous Open Hearth Process.

Mr. Talbot, who followed, remarked that the continuous open hearth process was at work on a 75-ton furnace in 1900, but now a 200-ton furnace is in operation in Pittsburg at the works of Jones and Laughlin, and furnaces of this capacity will shortly be completed in other parts of the States, in England, and in France. The Pittsburg furnace is oval in shape, being 17 ft. 6 in. wide in centre, with curved sides diminishing to 14 ft. 6 in. at the ends, and is 40 ft. long between ports. This gives a surface area at the fore-plate level of about 640 square feet. The furnace tilts both ways, so that slag can be taken from the slag-spouts in the fore-plates on the charging side of the furnace whenever desired, and this is done very satisfactorily. The ports consist of one gas-port in the centre, with an air-port at a slightly higher elevation on each side of it. An account is given with full particulars of a week's working of the furnace on liquid pig of the standard Bessemer used in the States, the additions being 80 per cent iron ore, scale, lime, scrap, and ferro-manganese, the latter 10½ lb. per ton of steel. Heats of from 40 tons to 50 tons were taken out about every 4½ hours; the carbon of the steel ran from 0·15 to 0·4, and the steel produced in the week amounted to 1,415 tons. At Frodringham the success of the process has encouraged its extension. Many good factors are cited, including rapid elimination of carbon, sensible heat produced by the burning of carbonic oxide to carbonic acid over the bath, the quiet elimination of the silicon, the treatment of hæmatite iron just outside the hæmatite limit, the ease of working, the reduction of labour, the increase yield from a single plant, etc. Some contended that it was more costly than fixed furnace practice, that 40-ton heats were too big, that it would not do for Cleveland pig, which Mr. Talbot said he was willing to leave alone. "Why has not Germany taken it up?" asked one. "Because of the magnificent basic Bessemer plants working cheaply in that country," replied another.

Hollow Pressed Axles.

Mr. Camille Mercader related how at the Homestead Works, Pittsburg, hollow pressed axles were produced from rolled steel blanks heated to 1,000 deg. C., and carefully straightened and cleaned from scale, by placing them in a two-part die and forcing in simultaneously cylindrical punches so as to form a hollow a third of the length at each end, leaving the central third solid and compressing all so as to take the form of the die. The powerful and precise machinery is described, and mechanical and other tests of the metal after treatment are recorded. But some did not like hollowed axles, whilst others saw in this process a similarity to Ehrhardt's; the author, however, defended himself effectively.

Alleged Cementation of Iron by Silicon.

Messrs. Moissau and Lebeau have said that silicon could, like carbon, cause cementation in hot iron. Mr. Stead has now tried heating prisms of iron and steel embedded in silicon, and unless fusion took place no silicon penetrated the metal even at temperatures between 1,100 deg. C. and 1,200 deg. C.

Influence of Sulphur and Manganese on Steel.

Professor Arnold and Mr. Waterhouse showed that sulphur has a preference for manganese, and that by adding manganese to a sulphur iron, instead of the low-melting and disastrous sulphide of iron, the higher melting sulphide of manganese is formed, which distributes itself like the slag in a good puddled iron and does not greatly affect the strength of the metal. But it must not be supposed that all sulphur irons can be rendered safe for all purposes by the addition of manganese. Sulphur irons, as a rule, will not withstand shocks.

The Electrical Furnace in Metallurgy of Iron.

Mr. Albert Keller has achieved the production of a half a ton of steel hourly in an electric furnace, at Livet, in the south of France, where a fine water power is available; the furnace consumes 2,800 kilowatt hours per ton of steel. Others present had seen the furnace and praised it, others again questioned the author's statement about the cost. The President suggested it was, perhaps, simply an error due to the use of English coinage units.

Slag Portland Cement.

Cecil von Schwarz pointed to the difference between slag cement, made by grinding slag and lime together, and slag Portland cement, made by calcining a mixture of slag and lime and grinding the clinker, and insisted on their not being confused. "But," said Mr. Hutchinson, of Skinningrove, "we have used our cement for sea-defence work which has stood thirteen years," and so said Mr. Stead.

Blast-Furnace Practice.

Mr. Sahlin described Mr. Julian Kennedy's arrangement by which access of air and explosions attributed to it are prevented or minimised; the top of the blast-furnace is closed air-tight and without explosion doors, so that any slight explosion would expend its energy in the downcomer. The arrangements include automatic charging arrangements, supported from the top of the furnace. "But," said M. Greiner, "these tall charging arrangements give rise to more dust, and this dust, and not so much the air, gives rise to violent explosions; given an irregularity in the working, scaffolding for instance, a rush of dust to the heated area ensues with disastrous results." Mr. Sahlin retorted that such a condition ought never to exist, and practice has testified to the security of the air-light top and automatic charger.

Dust in Blast-Furnace Gas.

Mr. B. H. Thwaite drew attention to the great loss of sensible heat resulting from the deposition of dust from the heating gas in the stoves, and suggested the use of producer gas in the stoves. Incidentally he mentioned the separation of dust from the blast-furnace gas by the use of brush discharge of static electricity, and emphasised the suitability of the gas for engines. Many dissented from the idea of erecting producers; others noted that the brush discharge had failed in a somewhat similar application; another spoke well for the Theisen washer. The rest of the papers were taken as read.

Mr. Carnegie said he was delighted to see how everything was criticised in the Institute; it certainly was no place for humbugs, they would very soon be exposed. A reception on the first night and a dinner on the second formed part of the functions of the meeting.

The Presidential Address.

At the dinner many notable speeches were made; the Duke of Devonshire pointed out, amongst other things, that the system of sharing profits, so ably advocated by the President, had been some years practised by Sir George Livesey at the South Metropolitan Gas Works in London. Mr. Balfour, the Prime Minister, in an eloquent speech, went further, and suggested that true prosperity could only be achieved by a sort of general profit-sharing amongst the nations of the world. When proposing "the Iron and Steel Institute" Sir Henry Fowler did not hesitate to say that "few recent speeches had produced a greater impression on the general mind of the commercial public than that delivered the previous day by Mr. Carnegie." He felt sure that they all thanked him for having put forward so eloquently and powerfully a solution of the conflict between capital and labour, which he himself had adopted with such signal success. The principle of conciliation and reconciliation, which Mr. Carnegie had not only advocated, but exemplified in his own commercial life, he had infused into a wider atmosphere. No public man of the present day had done more to influence peaceable feelings between America and Great Britain than Mr. Carnegie, but he had another aspect. Many men could make money, few men could keep it, and still fewer could give it away. In that respect he thought that Mr. Carnegie was at the top of the tree.

The whole of the arrangements of the meeting reflected considerable credit upon the secretary, Mr. Brough, and his staff.

Must we go Abroad for Electrical Machinery?

The present tendency of Englishmen to indulge in a kind of national modesty contrasts strangely with the breezy optimism of the American. The recent statement of Mr. Selby Bigge anent foreign competition before the Departmental Committee on Electricity in Mines, was, however, quickly followed by a completely opposite opinion. Mr. Bigge, according to the *Times*, said "*he found that whenever he wanted electrical machinery for work on a large scale he had to get it from America, or Germany, or Belgium, and we were at least four or five years behind these countries in the application of electrical machinery.* In Germany they were using 700 volts in practical mining work, but in this country there was next to nothing being done in that way. The three-phase system was used almost entirely on the Continent, and no other system could be applied on a large scale to mining operations. When on the Continent he was very much surprised to see the enormous machines in course of construction in Berlin and Frankfurt for two large electric lighting companies in London, and for Manchester, Belfast, and other places in the United Kingdom. Even Glasgow had to go to America for electric machinery, and whenever it was a question of machines of very special design or large size they had invariably to go to America or the Continent. The question of carrying power into mines for long distances, say two or three miles, had been solved by the German engineers. A great number of installations had been placed for underground work in the mines in Germany, and, owing to the good quality of material and the regulations made for safety, not a single life has been lost. In reply to Mr. Atkinson, who asked why we were behindhand in this country, the witness said that the restrictions on enterprise by the Electric Lighting Acts and the want of scientific training on the part of the managers had kept us back, but we were now beginning to wake up to the situation.

A Reply.

At the next meeting of the Committee, Mr. C. W. Mountain, electrical engineer of Newcastle-on-Tyne, said "he wished to repudiate statements which had been made the previous week by Mr. Selby Bigge, to the effect that if anyone wanted large generators they must go to the Continent of Europe or America for them. He did not think that Mr. Bigge was quite fair to the English manufacturers of electrical machinery in making those remarks, for there were firms in this country making as good generators as the Germans or Americans could. He had been through the German works, and had seen the particular generators to which Mr. Bigge referred, and he found that the principal reason for those generators being made in Germany was because English manufacturers were too busy and were not prepared to take them at the price at which the foreigners took them."

Another View.

In a question of this kind, it is well to look at the facts from a professional standpoint, carefully weigh the pros and cons, and form one's own conclusions. That Mr. Selby Bigge is not alone in his opinion is shown by the following letter received from a large firm of electrical engineers:—

"We can only endorse Mr. Selby Bigge's movement to get the laws of this country with regard to electricity in mines revised. We see no reason why, if coal mines on the Continent and in America can be worked safely with potentials of many thousand volts to the great advantage not only of mine owners but also of the

electrical industry in general, this should not be done in England under similar conditions, but, up to the present, practically nothing worth mentioning has been done in this direction. We cannot consider a plant in this country of 300 h.p. to 400 h.p. an important one in comparison with those of 6,000 h.p. to 10,000 h.p. on the Continent. Mr. Selby Bigge has made a bold stroke, and we admire not only his pluck but also his business ability and far-sightedness."

The Effect of Restrictions.

A gentleman who has a good deal to do with power and mining work writes as follows :—

"The development of the application of electric power to industrial purposes, and consequently of the electrical manufacturing industry, in this country, has been seriously handicapped in the past by restrictive legislation, promoted, in many cases, by opposing vested interests (such as the gas interests as regards the lighting development), in addition to our habitual caution in the adoption of new systems involving the possibility of danger to the public. While this country was experiencing a period of retarded development, the United States and the Continent, without the restrictions and difficulties that were encountered here, were progressing. Thus, when this country was ready to consider extensive developments in this direction, standards had been evolved by the process of time both in the United States and on the Continent, and rapid deliveries were obtainable. At the same time, our manufacturing industries had not been idle, but lacked the facilities which a rapidly growing market had afforded our competitors. At the present time, in spite of the difficulties mentioned and the consequent delay in the growth of manufacturing facilities for the production of electrical apparatus in this country, our facilities are more than sufficient to provide for the whole of the requirements of this country and the colonies. This is fully borne out by the large works for the production of electrical apparatus that have recently been established ; therefore, the statement made by a witness before the Departmental Committee on Electricity in Mining, reported in the *Times* of the 23rd ult., that when he wanted electrical machinery on a large scale, he has to get it from Germany, America, or Belgium, is not to-day borne out by facts. There is no necessity for purchasers to seek electrical machinery abroad on the grounds of inability to obtain it in this country. This is fully corroborated by the lists of tenders for electrical apparatus in connection with public works which are published from time to time, showing the large number of firms that are in a position to supply electrical apparatus to meet all requirements.

A Question of Price.

"The principal factor that has determined the placing of business on the Continent during the last two or three years has been the question of price. The Continental competitors [illegible] that it would be commercially unsound for English manufacturers, with higher labour charges and a reasonable amount of profitable business in hand, to fill their shops with work at such prices, which cannot possibly in many cases pay the standing charges. This competition is explained by the recent industrial depression on the Continent, particularly in Germany, due to the fact that large factories for the production of electrical apparatus were erected there some years ago during a wave of industrial prosperity, which resulted in both over-production and a surplus of manufacturing facilities, when the market returned to its normal state. A large number of electrical manufacturing companies on the Continent have been under the necessity of obtaining orders to fill their shops at all costs, if for no other reason than in order to minimise the loss on their standing charges, thus enabling them to keep their organisations together while waiting for improvement in the industrial conditions of the market.

"A new era has commenced in this country during the past three years, with the more extensive application of electric power to industrial purposes, and the necessity all branches of industry have found, through increasing foreign competition, to bring their methods up to the highest pitch of perfection, and so reduce the cost of production to the absolute minimum.

Superiority of Our Machinery.

"Many of our large electrical manufacturing companies have formed foreign connections, and have been improving on designs that have been evolved both in America and on the Continent so as to render them more particularly suitable for the English market ; thus our foreign competitor has no advantage whatsoever in design ; our methods of construction, if anything, are superior to those of our competitors, the resulting product being in many cases of a more substantial character and more highly finished ; and the design of the apparatus that is manufactured in this country is equal to apparatus manufactured in any part of the world, and for use in this country is undoubtedly superior to the majority of that imported, as the conditions in every country are necessarily different, and require different methods and treatment.

Not Realised.

"There is a great tendency on the part of some purchasers to place all their inquiries abroad without even attempting to familiarise themselves with the facilities offered by the various manufacturing companies established here ; the developments in this country during the past few years having been so rapid and extensive that they have not been fully realised by many. The witness above referred to is reported to have stated that in Germany a pressure of 700 volts was common in mining work, and that there was almost nothing of the kind in this country. This evidence left it to be inferred that there was nothing in this country of a similar kind because of

the want of progress on the part of the manufacturing companies and the lack of enterprise and ability on the part of the electrical engineering community. It is probable that this inference was not intended, but that is the impression that the report conveys. In any event, if any of our leading electrical engineering companies were granted the opportunity by our large colliery proprietors, they would have no hesitation whatsoever in guaranteeing satisfactory results under similar conditions with English-made apparatus from English designs. So far as the application of electrical power in this field is concerned, the want of development is almost entirely due to the hesitation shown on the part of the colliery owners to bring their equipments up to date, resulting, doubtless, from various causes such as a natural conservatism, a lengthened period of continued prosperity, during which they would not consider the inconvenience and probable loss of profit incident on any changes in their plant, and also the fact that fuel economy, which is one of the economies that all power users first consider, does not represent to them such a serious factor as to others with whom coal is costly. The economies resulting from greater expedition and convenience in handling tools, and processes cannot be estimated in figures, and thus proper weight is often not given to this important feature, the actual value of which can only be determined by experiment.

"The electrical industry is making rapid strides, and the majority of the large manufacturing companies have prepared comprehensive standards in different lines of electrical apparatus specially designed to meet the English market. There is also a tendency to a more liberal recognition of the electrical industry, by the removal of restrictions and a reluctance to impose prohibitive restrictions on new developments in Parliament that has recently given an enormous impetus to the industry as a whole."

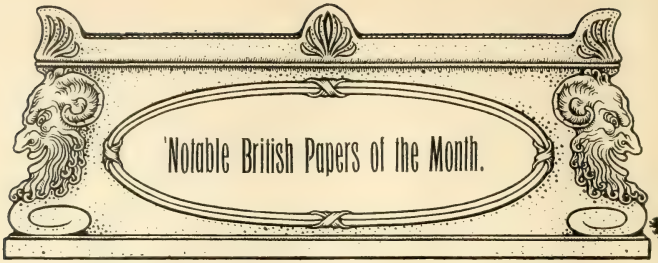
Proposed Watt Memorial.

An interesting memorial is projected in honour of James Watt, the Father of steam engineering. Mr. Andrew Carnegie has offered to give a sum of £10,000 towards a monument at Greenock that shall be of some practical use as well as a record, and many other large subscriptions are promised. The trouble is what form the memorial is to take, and the decision on this point will, no doubt, largely condition the public subscription. The Hon. J. C. Burns, son of the late and brother of the present Lord Inverclyde, Chairman of the Cunard Company, suggested that no better memorial could be founded than an experimental tank for shipbuilders and engineers, and this proposal is favoured by some. On the other hand, it is contended that such a tank would be of practical benefit to a part of mechanical engineering only, and that a memorial to James Watt should take a form which will be of interest and value to all users of steam power. The larger design is to make the memorial an international one—such as a College of Research, or an Institute to aid Invention.

With reference to the offer of Mr. Andrew Carnegie to contribute towards the formation of a permanent and useful memorial to James Watt, it is noted that the grandest tribute yet paid to Watt was that paid by the most eminent living electricians, in naming "a Watt" as the unit of electrical power all the world over. At the Chicago Electrical Congress of 1893, we are reminded that Britain, the United States, France, Germany, Italy, Austria, Mexico, Switzerland, Sweden, and Canada, all sent official representatives, whose recommendations were promptly adopted by the Governments concerned. These electricians resolved to advise the adoption of electrical units and names. The name of the founder of the science of electrodynamics, the great Frenchman, André Marie Ampere, was made to stand for "current." The aristocrat, Charles Augustin de Coulomb, stands for "quantity." Michael Faraday stands for "capacity." The American, Joseph Henry, stands for "induction." James Prescott Joule for "work." The German, Georg Simon Ohm, stands for "resistance." The Italian, Allessandro Volta, stands for "force." The famous James Watt for "power." Watt, in electrical nomenclature represents Power. Any good modern dictionary of the English language gives "a Watt" as the unit of electrical power, but is it always remembered why the unit is so-called?

Mr. W. G. McMillan.

On the occasion of a call at the new offices of the Institute of Electrical Engineers after the Italian tour, we found Mr. W. G. McMillan, the secretary of the Institute, under the impression that "everything would soon be straight." As, however, complete order appeared to reign throughout the nine rooms which comprise the flat, the deduction we drew from Mr. McMillan's remark and the state of the premises was that the Society possesses a secretary who knows the value of order; indeed, some ingenious adaptations of the card system and the excellent arrangement of the library and offices served to confirm this impression during our visit. The new headquarters offer a decided improvement upon the old premises, and are very close to Victoria Station.



A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

MR. ANDREW CARNEGIE ON THE MANAGEMENT OF MEN.

MR. ANDREW CARNEGIE'S Presidential address to the Iron and Steel Institute was devoted to "the organisation and management of that most complicated of all pieces of machinery—Man." He remarked that "in the early days the admission of young partners without capital was unheard of. The joint stock form did not lend itself readily to the substantial recognition of exceptional service from the exceptional man, yet it was in this direction that the most important changes had come in the business department."

PERFECT MANAGEMENT AND HOW SECURED.

Speaking from experience, we of the Carnegie Steel Company had not gone very far in manufacturing before discovering that perfect management in every department was needed, and that this depended upon the men in charge. Thus began the practice of interesting the young geniuses around us, as they proved their ability to achieve unusual results—the source of big dividends. These received small percentages in the firm, which were credited to them at the actual cash invested, no charge being made for good-will. Upon this they were charged interest, and the surplus earned each year beyond this was credited to their account. By the terms of the agreement, three-fourths of their colleagues had the right to cancel it, paying the party the sum then to his credit. This provision was meant to meet possible extreme cases of incompatibility of temper, or of the recipient proving incapable of development, or of enduring prosperity. At death the interest is reverted to the firm at its book value. The young men were not required to assume [illegible] until their share was fully paid by the profits, and there was no further liability upon it, was it transferred to them. Thus thoughts of possible loss never prevented concentration upon their daily duties. They were not absorbed in the daily quotations, for the shares were not upon the Stock Exchange or transferable. This policy resulted in making some forty odd young partners, a number which was increased at the beginning of each year.

By this plan they were rapidly paying for their interests and promising to become the millionaires of the then seemingly somewhat distant future which however, proved not so very distant. They are now rich men. You will not fail, however, to note that the plan kept them all in excellent training, as poor men, still living upon their salaries—millionaires in *posse* indeed, but not in *esse*—quite a difference, for millionaires seem liable to develop when still very young so many hitherto unsuspected weak spots in their constitutions requiring careful nursing, and many absences and short hours, and a dozen other impediments to hard continuous exertion, that it does not seem good for their robust health that they should be unduly burdened before reaching middle age. The zest of the chase is over too soon.

ONLY A "THUNDERING" SALARY WANTED.

We did not fail to see, as the works enlarged, how much success depended upon the mechanical men, the superintendents and foremen, yet not one of these had up to that time been admitted as partner. The business and the mechanical men—office and mill—were still widely separated. Well do I remember the first attempts to bring these two departments into closer relations. It was made with our Captain Jones, one of your members, well known and appreciated by many of you as in the foremost rank of managers, perhaps the foremost of his day in America. He came to us as a working mechanic at eight shillings per day. I explained to the Captain how several of the younger men in the business department had been made partners and were actually receiving much greater rewards than

he, while his services were at least equally valuable, and informed him that we wished to make him a partner. I shall never forget his reply. 'Mr. Carnegie, I am much obliged, but I know nothing about business, and never wish to be troubled with it—I have plenty to trouble me here in these works. Leave me as I am, and just give me a thundering salary.' 'Hereafter,' I said, 'the salary of the President of the United States is yours, Captain,' and so it remained till the sad day of his death. My seniors, the presidents of the other manufacturing concerns, did not fail to take me to task for ruining the steel business by paying a mechanic more salary than any of them received. Being much the youngest of these great dignitaries, I humbly confessed my wrong doing, not, however, failing to inquire if they knew where we could find two or three more Captain Joneses at double the price. We did not overpay the Captain; he was worth several ordinary salaried presidents. The Captain's refusal of partnership was the only one which ever came within my experience. None of the other mechanics ever preferred salary to partnership, and they were wise. Nothing can compare with that form. From that time forward the union of the mechanical and business partners went steadily forward until no manager of a mill was without his interest in the business, as pertaining to the position, and no board of management, or important committee, was without a mechanical representative. Thereafter, mill and office conferred upon all important sales and contracts. The mechanic and the man of affairs were in constant consultation and fellow partners—one of the most profitable changes that we ever made.

PROFIT SHARING.

There was another step taken in the same direction. Men having others under their charge were given an interest in the proceeds, or savings in cost, in their department. Where it was impossible to decide the limits of a department, the managers were rewarded by handsome bonuses beyond their salary, based upon the general profits of the year. This plan of reward according to results for heads of departments, has already become so general and is spreading so fast that we may be sure it has proved its efficiency. I never see a fishing fleet set sail without pleasure, thinking this is based upon the form which is probably to prevail generally. Not a man in the boats is paid fixed wages. Each gets his share of the profits. That seems to me the ideal.

The great secret of success in business of all kinds, and especially in manufacturing, where a small saving in each process means fortune, is a liberal division of profits among the men who help to make them, and the wider distribution the better. Unsuspected powers lie latent in willing men around us which only need appreciation and development to produce surprising results. You must also capture and keep the heart of the original and supremely able man before his brain can do its best. Indeed, this law has no limits. Even the mere labourer becomes more efficient as his regard for his employer grows. Hand service or head service, it is heart service that counts.

THE DEEP WELL OF MUTUAL REGARD.

Disputes of some kind between Capital and Labour are always in evidence, but it must never be forgotten that in the wide fields of domestic service and in that of the few employees with a working master, which combined, embrace by far the greater number of wage earners, all is, upon the whole, satisfactory; there reigns peace, with the inevitable individual exceptions. We see in this encouraging fact the potent and salutary influence of the personal element. The employer knows his men, and the men know their employer; there is mutual respect, sympathy, kindly interest, and good feeling—hence peace. The friendship of the employers and their children for the old servants, and the affection of these for their masters and mistresses and their children, is one of the most delightful features of life. What has produced this reciprocal affection? Not the mere payment of stipulated wages on the one part and the bare performance of stipulated duties on the other—far from this. It is the something more done upon both sides, and the knowledge each has had opportunity to gather of the other, their virtues, kindness—in short, their characters. The strict terms of the contract are drowned in the deep well of mutual regard. Labour is never fully paid by money alone.

If the managing owners and officials of great corporations could only be known to their men, and equally important, their men known to their employers, and the hearts of each exposed to the other, as well as their difficulties, we should have in that troublesome field such harmony as delights us in the domestic.

THE SLIDING SCALE.

Passing over the day when the employer of capital owned and managed his workmen as slaves, it is surprising to note that even as late as 1799 villeinage still lingered in Scotland. Miners and labourers were practically transferred with the mine when it was sold. Speaking recently to a most intelligent miner in Fife, I mentioned the fact that our forefathers were thus transferred. To the inquiry what would be thought now if the employer desired to transfer the men with the mines, he replied: "Aw, there would be twa at that bargain, I'm thinkin'." You have to be Scotch fully to appreciate the reply, for much lies in the accent, the twinkle of the eye, and significant nod.

The payment in merchandise, in whole or part, and the obligation to perform certain duties to the employer lingered after villeinage passed away, but to-day we have reached the stage of perfect equality between the two contracting parties. Each is free to demand terms or to terminate agreements. But the irresistible pressure which has forced change after change in the relations of capital and labour still operates unchecked—a sure indication that the final stage has not yet been reached. We have evidence of this in another important advance, the sliding scale, which provides

not a fixed wage, but in some degree a settlement by results. If I were asked what was the best service the Carnegie Company was ever able to render the wage-earner, next to giving steady employment at wages equal to any, I should answer it by persuading them to adopt the sliding scale, with a minimum insuring living wages, at its works at Braddock, fourteen years ago, which has given perfect satisfaction from that day to this, and is still in force, and has produced undisturbed harmony between capital and labour.

EMPLOYEES' INVESTMENTS.

While, as you have seen, the Carnegie Company interested its young men as partners and was always anxious to reward exceptional service, and carried the bonus to an extent, perhaps, unknown in any similar organisation, the masses of the ordinary workmen could not be embraced under the limited partnership form, even if it had been thought desirable that their savings should be so invested. The objection to this from the point of view of the workman, and which we were never able to surmount, was the instructive fact that the majority of the largest manufacturing concerns in the United States have, at some period in their career, either been in the hands of receivers, been mortgaged, reorganised, or sold by the sheriff to the great loss of their original owners. More than once in the history of the Carnegie Company, leading partners have been so doubtful of its future as to beg their more optimistic senior to buy large amounts of their interests at actual cost. The great Cambrian Iron Company was twice in trouble, and once sold by the sheriff; Joliet Works were also so sold; the Bethlehem Company has twice been mortgaged; the six per cent. first mortgage bonds of the immense Chicago Works have been sold for as low as 70 per cent. and its shares at less than one-half of their par value.

The Troy Iron and Steel Company has lost heavily and undergone several reorganisations. It may be said that these disasters are of the distant past, but history has a way of repeating itself which we do well to remember. The Pennsylvania Steel Company has in recent years been in the receiver's hands. Its shares, in demand at $300 in 1881, sold in '93 as low as $20. There was no over-capitalisation in any of these companies. Only actual cash counted. It is just announced that our oldest and largest shipbuilding company must be reorganised, for which seven and a half million dollars (one and a half million sterling) are needed. Its shares, which have sold above $85, are now at $38. The vicissitudes of the leading iron and steel concerns of Tennessee and Colorado are still in evidence. Our friends in Canada have similar experiences. Shares of their large Dominion Iron Company, which sold at $60 last month, are quoted to-day at $25.

Our experience in America has not been peculiar. The year before last the iron and steel works of Germany were generally in depressed conditions, and their shares suffered heavily. Your own experience in Britain is similar.

Had the employees of leading American railway systems invested in their shares last year, they would already have lost nearly a quarter of their savings. Pennsylvania Railroad shares having fallen $38; New York Central, $40; Chicago, Milwaukee and St. Paul, $41; Illinois Central, $42 per share. It will be said that these losses may be recovered. Quite true, but also true that they may be doubled. No man can tell.

It is this ever present danger of loss to the investing workman in all fields of investment which makes the Government Savings Bank of Britain so great a boon, although only 2½ per cent. interest be allowed. The principal is absolutely safe, and this is the vital point without which little genuine good to the workers can result.

HOUSE BUILDING.

Bearing all this in mind, the thought of asking the working man to risk his precious savings in the manufacturing or any form of business was always discarded by us as too dangerous for him. He was advised to buy a home instead, and save his rent. To facilitate this, money to build a home was lent to any employee who had the ground clear of debt. Their savings up to $2,000 each were taken by the Company and placed in a special trust fund, entirely separate from the business. Interest at six per cent. was allowed to encourage the workman to save part of his earnings for old age. The funds received were lent upon mortgage on real property, generally to such workmen as wished to build homes. It was believed that this was the safest, and therefore the wisest, use of their savings which workmen could make.

The most convincing proof of the steady march of labour towards a recompense based more and more upon profits, or dispersed in forms drawing capital and labour into the peaceful bonds of mutual obligation, is to be credited to the United Steel Company, the largest of all industrial corporations. For this it deserves unstinted praise, as proving a genuine consideration for the interest of the workmen and sagacious thought for its own.

THE UNITED STEEL COMPANY'S PLAN.

To this step I invite your earnest attention, for it may well prove of surpassing importance and mark an epoch in the history of the relations of capital and labour. It may even be looked back to as having furnished the solid foundation for the solution of most of the troublesome questions between them.

It is in this form: Twenty-five thousand of the $100 shares of preferred seven per cent. stock were offered to its 168,000 employees at $82.50 per $100 (£16.12 per £20) share, in different amounts according to their earnings. These were subscribed for twice over; nearly one-sixth of the men subscribed—one-half being salaried men. Twenty thousand more shares of stock

were afterwards provided, making 45,000 in all, worth about $4,500,000 (£900,000); monthly payments being received. Another distribution of shares is intended next year.

One valuable and praiseworthy feature is that for five years those holding their shares and still in the service are given a yearly bonus of $5 upon their shares, and during a second five-year term a bonus, amount not yet fixed, is promised. The third feature, equally praiseworthy, is the resolve to set apart yearly from earnings, should these exceed $80,000,000 (say £16,000,000), one per cent. of the earnings, and for each $10,000,000 (£2,000,000) of earnings an additional one-fifth of one per cent., for a fund to be awarded to such of their officials and men as have in the opinion of the Finance Committee, best deserved it, as a reward of merit, and not *pro rata*.

It will be noted that the investment is at the risk of the men. This seems a feature which we may, however, expect the Corporation to change as experience is gained, as the plan is most widely stated to be subject to future changes. The working-man, who, necessarily unacquainted with business, buys his shares upon trust, and becomes the beneficiary or the victim of his employers, should be considered as an inexperienced youth in the affair; besides, he is asked to invest, not solely for his own advantage, but at least equally for that of his employer. His adviser is not a disinterested party, and therefore cannot be absolved from responsibility, which would, I am confident, lead the owners of the United States Steel Company to save their trusting workmen from loss through following their advice, this advice being intended to promote the mutual advantage of the Company and the workers. The responsibility is not small, since the circular assures the workmen they are offered "a safer and more profitable investment than the workman could possibly find for his savings elsewhere." How much better, therefore, that the legal form should be given to the moral claim.

There is another consideration, the influence upon the prudent workmen of distracting anxiety in regard to the absolute safety of what may be his sole provision for old age. He will see every morning the Stock Exchange quotations, for the American workman reads the papers. Only recently he would have seen the preferred stock of the United States Steel Company temporarily quoted lower than the price charged for it to him. This may mean little to the man of affairs familiar with the ups and downs of the mercurial Stock Exchange. But what must be the effect upon the uninformed workman? Of this I am well assured: the workman whose thoughts are upon the speculative surprises of the Exchange will not prove desirable. Speculation is the parasite of business, feeding upon values, creating none, and is wholly incompatible with the satisfactory performance of other regular work requiring constant care and caution. In the interest of the employer, therefore, as well as that of the workman, the savings of the latter should be secure.

THE LABOURER AS CAPITALIST-PARTNER.

Thus we see, gentlemen, that the world moves on step by step toward better conditions. Just as the mechanical world has changed and improved, so the world of labour has advanced from the slavery of the labourer to the day of his absolute independence, and now to this day, when he begins to take his proper place as the capitalist-partner of his employer.

Perhaps I may be considered much too sanguine in this forecast, which, no doubt, will take time to realise, but as the result of my experience, I am convinced that the huge combination, and even the moderate corporation has no chance in the competition with the partnership which embraces the principal officials and has adopted the system of payment by bonus or reward throughout its works. The latter may be relied upon as a rule to earn handsome dividends in times of depression, during which the former, conducted upon the old plan, will incur actual loss and perhaps land in financial embarrassment. In speaking of corporations we must not forget, however, that there are many which are corporations in name only, their management being the life work of their few owners. These rank with partnerships, having all the advantages of this form. The true corporation is that whose shares are upon the Stock Exchange, and whose real owners change constantly and are often unknown even to the president and directors, while to the workmen they are mere abstractions. The step taken by the United States Steel Corporation is, therefore, no surprise to me, for I have long believed that such corporations would be compelled to adopt the best attainable substitutes for the personal factor of the older system, or suffer.

In the percentage allotted by the plan to reward exceptional officials we have for the huge corporation perhaps the best substitute attainable for the magic of partnership, which nothing, however, can approach. The reward of departmental officials may readily be secured under this provision. In the bonus granted yearly upon shares held by employees we have proof of regard for them which cannot but tell, and the distribution of shares in the concern among them has an advantage, which, so far, no partnership even has enjoyed. The latter will no doubt adopt the plan, or find some equivalent, for the workman owning shares in absolute security will prove much more valuable than he without such interest. The idea of making of every workman a capitalist and of sharing large percentages of the profits among those rendering exceptional service will probably encounter the opposition of the extremists on both sides, the violent revolutionist of capitalistic conditions, and the narrow, grasping employer whose creed is to purchase his labour as he does his materials, paying the price agreed upon and ending there. But this opposition will, we believe, amount to little. It will even speak well for the new idea if scouted by the extremists and commended by the mass of men who are on neither dangerous edge, but in the middle, where usually lies wisdom.

THE PREMIUM SYSTEM.

By Mr. James Rowan.

(Continued.)

A CONVENIENT way for the workman to calculate his premium is to multiply the time taken by the time saved and divide the product by the time allowed. This will give him his premium in hours, which, multiplied by his ordinary time rate of wages per hour, will give his premium for the job.

Taking the case already given as an example :—

$$\frac{\text{Time worked} \times \text{time saved}}{\text{Time allowed}} = \text{Premium in hours.}$$

$$\frac{12 \times 4}{10} = \frac{48}{16} = 3 \text{ hours premium.}$$

Multiplying this by his ordinary time rate he gets $3 \times 8\text{d.} = 24\text{d.} = 2\text{s.}$ as his premium for the 12 hours worked. Premium hours will be paid to the nearest quarter of an hour.

The following conditions will be observed :—

(1.) The time allowed for any job will be fixed by the management, and will be, as near as can be ascertained, the time which should be taken to do the job when working on time.

(2.) The time allowed will include all the time necessary to procure tools, set up machine and obtain material for doing the job.

(3.) For calculating the premium, the time taken on a job will include all working hours between the starting time of the job, and the starting time of the next job.

(4.) A time allowance, after it has been established, will only be changed if the method or means of manufacture are changed.

(5.) The hourly rate of wages will in all cases be paid for the hours worked. If a man takes longer to do a job than the time allowed, this will in no way affect the premium which he may have made or may make on any other job.

(6.) Overtime, nightshift, and other allowances will be paid to the men on the same conditions as already prevail.

(7.) In the case of overtime and nightshift, the premium will be calculated on the actual time worked, without taking the extra time due to overtime, etc., into account.

(8.) If an article turns out defective while being machined and is condemned, due to a flaw in the material, the workman will receive no premium on that article (of course, he gets his time wages); but if he has several articles on the one "line" and one of them is condemned, due to a flaw in the material, he will still get the premium, if earned, on the rest of the articles.

(9.) If a man's workmanship when finished does not pass inspection, he will receive no premium for that article unless he can make the work good within the time allowed, in which case he will still receive any premium earned.

(10.) In cases of dispute the matter will be referred to the management, whose decision shall be final.

(11.) Each workman on starting

5	—	—	—	—	70	21	42	3	10½	Date 16. 12. 02.					
6	225	75	22½	111	164	57½	5	1	22½						
8	24	33	19	13	169	69	12	21½	44½						
19	35	28	3	17½	193	184	4	38½	90	163	—	—	—	—	
20	82	8	65½	55	204	36	36	18	18	208	14	2	9	10	
23	30	1	2	20	236	13½	6	5¼	9	209	90	6	9½	29½	
24	216	54	110	108											
25	48	8	33	24	56	15	51	1	×	160	77	15	20½	50	
30	12	6	3	9	63	35	5	7½	26	171	19½	9	12	10	
31	13	18	9	×	69	36	15	17	18	191	22	1	12½	17	
36	14	2	11½	9	82	50	1	19	38	222	2½	3	1½	×	
37	29½	2	20	21	142	7	20	3	×	224	11	1	7½	7	
44	92	38	12½	55	153	11	1	5	×	231	—	—	—	—	
61	16	1	8½	8	165–6	88	4	17½	29½						
71	35	70	4½	17½	183	—	—	—	—	10	14½	8	6	10	
75	55	11	19½	27½	184	15	1	12½	12½	66	39	3	9½	19½	
167	—	—	—	—	206	29	1	12½	14½	214	30	2	1½	18	
168	30	2	10	20	225	28	1	20	21	215	26	8	13½	19	
170	55½	3	25½	24											
192	49	1	6½	18	9	12	20	2	×	161	13	1	1	6½	
210	78½	11	41½	39½	13	30	6	2	21	182	42	295	37½	31	
					18	12	1	6	5½	194	60	3	43½	30	
21	—	—	—	—	32	134	2	33	90						
22	85	1	19	12	33	20	28	10½	×	64	37	728	18½	27	
28	11	9	7½	8	62	44	13	31	×	201	31	302	20½	15½	
33	65	9	6½	4½	65	16	17	3	×	239	57	114	7½	29	

FIG. 2.

a job will receive a "Job Ticket," or "Line," on which he will find a description of his job, the time when started and the time allowed. When the job is finished he will return his "line" to his foreman, who, if satisfied with the work, will initial and write on it the time when finished, which will be the starting time of the man's next job.

(12.) In the case of a job requiring the services of a squad of men, a time allowance will be fixed for the complete job. If the total time taken by the squad is less than the time allowed, a premium will be paid to each man in the squad. This premium will have the same relation to his time wages for the job, as the time saved by the squad will have to the time allowed.

(13.) Fitting-shop apprentices in their first year will not receive "lines." Those in their second and third year will be considered junior apprentices, and 50 per cent. of the time they spend on a job will be calculated against it for premium. The percentage thus found will be paid on the whole time which they spend on the job.

For example, suppose a junior apprentice is allowed 16 hours to do a job, and does it in 16 hours, 50 per cent. of the time which has been taken to do the job, that is, 8 hours, is taken as a basis for calculating the premium, therefore he has made 50 per cent. on the job. If his rate is 14d. per hour he will receive 3s. instead of 2s. for the 16 hours worked.

Fitting-shop apprentices in their fourth and fifth year will be considered senior apprentices, and 75 per cent. of the time spent by them on a job will be calculated against it for premium. The percentage thus found will be paid on the whole time which they spend on the job. For example, suppose a senior apprentice is allowed 16 hours to do the job and does it in 16 hours, 75 per cent. of this time which has been taken to do the job, that is 12 hours, is taken as a basis for calculating the premium, therefore he will make 25 per cent. on the job. If his rate is 2d. per hour he will receive 3s. 4d. instead of 2s. 8d. for the 16 hours worked.

(14.) Apprentices at machines will be allowed 25 per cent. more time on a job than a journeyman.

The introduction of the premium system will, we believe, lead to the workmen suggesting improvements, devising better methods of doing many jobs and pointing out defects in machinery and tools, as they will at all times participate in the savings due to their suggestions.

ESTABLISHING A BARGAIN.

The publication of such a pamphlet as the foregoing in any workshop, will no doubt establish a bargain between the employer and the employed. It will enable the workmen to calculate their own premium and indicate how the system will benefit both the employer and the workman. A bargain of this description must be honourably adhered to. So soon as the requisite data have been gathered for a machine, the man working it should be put upon the premium system. A "line," as previously described, is given to each man working a machine.

Class :—Turners. Pay ending 4th December 1902.

No	Name.		Time. F.	S.	M.	Tu.	W.	Th.	F.	S.	M.	Tu.	W.	Th.	Total Time.	Time Allowance.	Rate.	Amount. £ s. d.	Inf. d.	Total Wages. £ s. d.
61	John Mathieson	Lost Time															d.			
		Overtime															9			
		Daily Total	9¼	5¼	9¾	9¼	9¼	9¾	9¾	5¼	9¾	9¼	9¼	9¾	108			4 1 0	1	
		Premiums	9¼			9¼	1¾					24	3¼		47½			1 15 8		
		Money Allce.																		5 16 7
62	Wm. McGowan	Lost Time			3												9 25			
		Overtime																		
		Daily Total	9¼	5¼	6¾	9¼	9¾	9¾	9¾	5¼	9¼	9¼	9¼	9¾	105			4 0 11	1	
		Premiums	6			5						6	7¼		24¼			18 8		
		Money Allce.																		4 19 6
63	Wm. Riddell	Lost Time	½		3				½								8·75			
		Overtime																		
		Daily Total	9¼	5¼	6¾	9¼	9¾		9¾	9¾	4¼	9¼	9¼	9¾	104½			3 18 9	1	
		Premiums			27	1					21½				48½			1 15 6		
		Money Allce.																		5 11 5
64	H. Abercrombie	Lost Time		¼	¼				¾	¼										
		Overtime																		
		Daily Total	9¼	5	9½	9¼	9¾	9	9¼	5¼	9¼	9¼	9¾	9¾	106¼			3 11 0	1	
		Premiums							21½	2		3½			26¾			17 10		
		Money Allce.																		4 8 9

Each page provides space for 10 men. Full working time per fortnight, 108 hours.

FIG. 3.

The "lines" are prepared in the rate-fixing department and issued to the foreman, who give them to the men. Extracts from them are entered on a "Daily Record Card" (fig. 2).

There are five columns on this card, the first column is for the machine numbers, the second for the time allowed, the third for the number of articles on each "line," the fourth for the times the workmen have been working on the job up till 10.30 a.m. on the date on the card (any other convenient hour may be used), and the fifth for the record times—that is, the shortest time in which each job has been done previously. This card is made up daily.

When a man is on the same job as on the previous day the particulars are repeated; there is added, however, to the time taken the time worked by the man in the interval. This card keeps the rate-fixing department in touch with the lines that have been issued, and is also invaluable for letting employers and managers know how the work is progressing. They can learn how a job is progressing by a glance at the card, which can be folded in the centre and carried in the pocket.

When a man has finished his job, he returns the "line" to his foreman, who writes on it the hour when the job was finished, and initials it, if satisfied with the work. The foreman then hands it to the rate-fixing department, and at the same time intimates what the man's next job is to be. The working hours, between the starting time of the job and the finishing time of the job, are put on the "line" (by the rate-fixing department) from the Workmen's Time and Wages Book (fig. 3), and the premium hours calculated, say, off a slide-rule, and put on the "line." The premium hours are then entered in the Time and Wages Book, under the hours worked on the day on which the job is finished. At the end of the pay * the hours worked are added together, and extended, giving the man's time wages for that pay; the premium hours are also added together, and extended, giving the man's premium for that pay; these two items—time wages and premium—are then added together, and this, with the addition of allowances for overtime, night-shifts, etc., gives the man's total wages.

The men are paid their time wages up till Thursday night at stopping time, if the pay day is Saturday, and their premiums up till Wednesday at stopping time.

GETTING A REASONABLE OUTPUT.

Most people would think that the workman who has been constantly working a machine should know the times the various jobs should take him, but, in a time shop, this, as a general rule, is not the case. He under-estimates his own ability, thinks he could not do the work much faster, and has simply no idea of the short time in which he can do a job, until he has the inducement of a substantial increase of pay to look [illegible]. When a workman first starts on the [illegible] means the fortnight or week over which [illegible] made.

premium system, he is often dubious about the time allowed and looks on it with suspicion, but when he does the job and finds the time allowed is reasonable, if he has not made a premium the first time, he will likely do so the next time he gets a similar job. Although it is one of the features of the system, that a man need not earn a premium unless he chooses, it has been the author's experience that, if one gives the average workman the chance of honestly adding to his earnings, he will do so. Having once started to make an increase of wages the workman naturally begins to educate himself as to the best methods of producing his work quicker. He devises new methods, and when he sees a man able to produce the work faster than himself, he adopts the methods of that other man. The employer and manager also take an interest in the times the jobs take, and by means of the daily record card already described soon find out the machines that take a long time to do their work. If it is the fault of the man, it can generally be improved by telling him how the job can be done faster, educating him in fact. If it is the fault of the machine, it may not be so easy to remedy; if only requiring to be repaired, or to have some small improvement, that is easily got over, but if the machine is not powerful enough—a very common defect—or of bad design, often there is only one remedy, and that is a new, accurate, and more powerful machine. This is a drastic cure which would not suit every firm, but when there is plenty of work for the new machine it should soon repay itself. The chief point is, that the firm should be satisfied that they are getting a reasonable output from their machines considering their condition.

As the workman gains confidence that his time allowance will not be reduced, no matter how short a time he takes to a job, he gradually reduces his time.

AN ILLUSTRATION.

The premium system was started in the author's works in February, 1898, and to illustrate the gradual improvement that has resulted since its introduction, it may be mentioned that the times taken by all the machinemen have, on an average, been reduced during the four succeeding years by 20, 23, 31 and 37 per cent. respectively. The earnings of the men have consequently increased by these percentages.

The author's firm has given every assistance in accomplishing this reduction of time by general improvements in many directions. Some would say that the men had formerly been loafing, or that the works were indifferently managed; yet there is no reason but to believe that the men were honest enough and that the management was fairly good.

A machine foreman should only have as many machines under his charge as he can attend to, including careful inspection of the work before it leaves the machine shop. Erectors, when working on time, will take a job from the machines, and if not correct will make it right without complaint, but if these same erectors are to actually lose money by the carelessness of a machine man, as they would on premium, they

rebel, with the result that great care is taken by the men and foreman that work when it leaves the machine is correct.

In his works the author has conferred at various times with many of the men, and they frankly admit that they are thoroughly satisfied with the premium system, and would not care to go back to the old time system. As a matter of fact, there are now fewer changes amongst the workmen than before the premium system was started.

One advantage of the introduction of the premium system is, that it enables the management very readily to look personally into the progress of the work in the workshop, which is far more effectual than studying reports in the office on the progress of work.

Up to this point the system has been treated as applied to the machine shop, but it is equally applicable to the erecting and other departments. In the machine shop every man is given a "line" for his own job, that is to say, each man works on his own account, but there are a few exceptions to this; and it will always be found better, if possible, to arrange for each man to work on his own account. Departure from this rule should only be made when absolutely necessary.

FOREIGN COMPETITION AND THE ENGINEERING OUTLOOK.

THE following extracts are taken from a paper read at a meeting of the Newcastle and District Association of Foreman Engineers and Mechanical Draughtsmen, by Mr. T. Kenyon (President). The paper also dealt with the premium system, but in the first portion the author took up the cudgels on behalf of the "Britisher," and deprecated the hard things said of him in connection with foreign competition:—

A SERIOUS ACCUSATION.

For a considerable period we have had all sorts and conditions of men writing and stating that the engineering and allied industries of Great Britain have fallen so far behind the American and German that we have lost our lead almost beyond hope of recovery, and that it will require complete and revolutionary changes in designs and in methods of manufacture if we are to regain even a portion of the trade we have lost. A considerable number of the speakers and writers suggest that the Americans and Germans are superior to us in ability and other admirable qualities. Well, they are quite at liberty to tell us the truth about any shortcomings we may have, but I don't think it quite fair for them to conclude that our competitors are superior to us because they have succeeded in getting their goods into many markets and hustling ours out. Such a conclusion is a serious accusation against the ability of the Britisher from top to bottom.

I think we have a perfect right to defend ourselves so far as we can honestly do so, and I purpose, in the course of this paper, to set up a defence against our accusers by showing how unfair a great deal of the competition is, and that quite as much of their success is due to other circumstances as to their ability, and thus prove that we still have a reputation for skill and ability which can be defended, and which, by a fair standard of comparison, is not one bit inferior to that of our competitors.

STATED, BUT NOT PROVED.

Some of our accusers say we still jog along by stage-coach methods, which all the world, except ourselves, discarded long ago; that our tools are unsuitable, that our methods are not good, and many other undesirable things are stated, but not all proved against us. Well, some of it is true and some the other thing; we are naturally a very conservative people, we change slowly, and seldom discard tried and trusted methods without being fully assured that the change is going to be beneficial; but once assured that a change is an advantage and a necessity, I dare say we prosecute it with as much vigour, intelligence, and determination as our competitors, but we fail to make a noise about it and advertise it as they do; but, although our competitors are not all they are advertised to be, at the same time we cannot shut our eyes to the fact that there is a substratum of truth in the statements we hear, which we cannot as individuals, or as a nation, afford to ignore; and while I believe the Germans or Americans, either individually or collectively, are not superior to the Britisher, yet we must admit that they are ingenious, enterprising, and bustling; that they have produced special machinery and appliances for doing work by unskilled attendants, which, by previous means, could only be done by highly skilled workmen, and in this respect they have taught us lessons in the perfection of machinery for special purposes. I am pleased to say, our machine tool manufacturers were not long in realising their position, and rose to the occasion, with what success I shall show later on.

AMERICAN IDEALS.

I do not wish in the slightest degree to underestimate the undoubted ingenuity and usefulness of this special machinery, most of which comes from America; yet I cannot help thinking that much of the inventive genius shown has been due to circumstances rather than to superior ingenuity or skill. That necessity is the mother of invention is an axiom as true to-day as in the past, and while we have been perfecting the skill and ability of our workpeople so as to get the best results out of our machinery, or by hand where machinery had not been shown to be applicable, the American had been perfecting his machinery to enable him to do without this skilled labour which took so many years to mature. His country was so large, and developed so rapidly, that it was utterly impossible for him to get the necessary amount of skilled labour to meet his requirements, consequently necessity

compelled him to design machinery which should in itself be so perfect as to be nearly automatic; therefore, it only required a few weeks or months for an intelligent workman to fully master the machine and produce excellent work. The next step was to attract the best men by offering inducements in the shape of premium or monetary reward, according to the amount of work satisfactorily done in a given time. The American manufacturer, by these changed methods, was quickly in a position to cheapen and enormously increase his output, and soon began to hustle and elbow us in the markets which we had felt we were secure in, and even extended his hustling into our own country, right to our very doors; and so successfully have they done this that some of our people cry out "our days are numbered if we don't wake up and adopt the methods of America and Germany."

"COMPETITION TO BE TACKLED AND BEATEN."

There is no doubt whatever that we must wake up to the fact that other countries are competing strongly and successfully against us in the markets of the world; and even in our own country, they have established a trade which we have got to fight against successfully, or take a back seat. I hope and believe we shall combat it successfully, but it will be no easy task. This is, I believe, fully realised by most people employed in engineering establishments in this country—from the employer down to many of our workmen, they realise that the competition is real, and has got to be tackled and beaten. I don't think there would be any great difficulty in beating it if we all started off the same mark; but we don't, our competitors handicap us very unfairly. They will not let us send goods into their country without heavy taxes having to be paid on them; in fact, he does all he can to increase the price of our goods, so that he may keep them out of his own country, and keep his market to himself.

UNFAIR COMPETITION.

He is assisted in his trade by the State, by private philanthrophy, by protective tariffs, and by similar unwholesome methods they shut us out of their markets, and are thus enabled to sell to us even at a loss for the purpose of capturing our markets, under the full assurance that any loss they incur will be made up from the sources named. State aid and State tariffs cause their consumers to suffer along with us. How long can this private and public assistance last?

Our competitors hope to make it last long enough for them to capture all our trade. I hope and believe they will be mistaken, and find they have got the wrong sow by the lug this time. A couple of instances will show how real and how unfair this competition is, and how little of our competitors' success is due to superior ability.

The first one is copied from the *Hardwareman*, and relates to the German tariff on sewing machines: "It is now realised that the new duty on sewing machines imported into Germany is so high, that both the English and American trade in them is utterly [illegible] worth of machines to Germany [illegible]

worth of machines, and America sent £225,000 worth. The German manufacturers are jubilant over the capture of this £405,000 worth of work, and foresee the annexation of the English market as a result of the prices they will be able to charge to their home consumers, and the cheapening of manufacture as a result, and of manufacturing larger quantities without competition."

You will carefully note that they do not expect to capture the American market, because they are quite sure that America will retaliate.

The second is an American case, and is in connection with giving orders for ships by the new Atlantic Shipping Trust, who a short time ago got tenders from American yards, and Harland and Woolf, of Belfast, and, although the Belfast firm's tender was an enormous sum less than the American tenders, the work was given to American yards.

Now, American companies and trusts do not throw money away by buying in the dearest markets without a very important reason: we must, therefore conclude that the trade of America and Germany is a serious national question—so much so, that private manufacturers who push the nation's trade know they will be subsidised, and otherwise assisted by the nation.

UNDERSELLING.

I don't think we need be very wide awake to see that subsidising private manufacturing concerns at the expense of the State, and therefore of the people of the State, also by private philanthropists of the State, cannot go on for many years longer, and I believe our competitors know this; but they hope that they will receive aid for a sufficient length of time to enable them to undersell us, capture our markets, and during the process compel us to close our workshops.

I am sorry to say the underselling has brought, and is bringing, some of our shops very near to the closing condition, and I trust few will give in, but fight through to the time when our competitors can no longer receive the aid which gives them a deceptive credit for superiority. We were at one time leaders in the engineering and manufacturing world; other nations saw and envied the power, wealth and stability of the "nation of shopkeepers," as we were dubbed by Napoleon. They have imitated us, and while we rested on our oars, they, with the help of the State and similar assistance, have in some instances gone ahead of us in the race, and thus awakened us to the necessity of changing our methods if we intend to regain our position. I hope and believe that, as individuals, as communities of individuals, and as a nation, we have a strong desire to get on even terms, and eventually to be foremost in the race again. Why should we not do it?

We have not lost our traditional courage and determination. This was fully proved by both our regular and our citizen soldiers in the late war in South Africa.

IN THE MACHINE TOOL WORLD.

Some few years ago they produced machinery so unique, so beneficial, so superior to many of our machines in capacity and in cheapness of work done on

them, that our machine manufacturers found themselves very much asleep. With characteristic pluck, they did not knuckle under, but set their wits to work, with the result that, I believe, it is now possible to buy British designed and British made machinery equal to, if not better in ingenuity, adaptability, power and stability to American or German machines made for the same purposes; thus, our machine tool designers and makers have shown that by waking up, sticking to what was good in their old designs, adding new features and principles, and developing old ones, they possess skill equal to their American and German competitors; this is exceedingly satisfactory, but it is exceedingly unsatisfactory to feel that they might still have been in the same sleepy condition if foreign machine tool competitors had not gone ahead of them in the race.

THE REIGN OF MACHINERY.

What our machine tool makers have done can be successfully imitated in many other branches of our trade. A great deal of our competitors' success is due to the very great use they make of machinery. They never approached us when engineering depended almost entirely on the hard practical judgment and skill of our manufacturers and workmen, who, up to some eleven years ago had few equals, and no superiors; but machinery has developed so rapidly, and superior education has entered so largely into the life of the workshops of the world, that the hard headed practical skill, adaptability and judgment of our hand labour, of which we are still justly proud, is no longer the greatest factor in the case; it has been hustled out wherever machinery could be applied, because it is costly, and there is a limit to the amount of work which can be done by hand in a given time, but he would be a bold man who would predict the limit of the output of work by machinery in these days of rapid development of machine tools.

THE FUTURE.

Our competitors are fully alive to this, and take the utmost advantage of it. Their energy, their hustling, and their competition are real, and having got the machinery, their next step was to get the greatest possible output from their machinery or by hand where machinery could not be applied—their methods all tend the same way. Wherever an incentive to greater individual effort can be applied it is applied. Herein lies one of the secrets of their success: they don't believe in, and won't have uniformity of production, but aim at getting the highest possible amount which can be produced by machine or by hand in a given time. If we are satisfied that, man for man, we are as good and capable as the American or German, and only need to alter our methods by taking a leaf out of our competitors' book, and by the premium or bonus, or similar system, offering inducements to our workpeople to use the skill they possess to its utmost capacity, the result would soon prove that we are taking the lead again, in spite of the artificial bolstering and propping up of our competitors' trade by State aid and similar unwholesome methods.

I trust I have, by reason and by comparison, proved that our case is not so hopeless as it seems, or that some speakers and writers would have us believe, and that we only want to wake up and develop the skill and capacity of our people to prove that we are not, and never have been inferior to our foreign competitors; we simply want to be always on the alert to improve, increase and cheapen our productions, suit ourselves to the wishes, tastes, and requirements of our customers, never being satisfied that there cannot still be some further improvement made. Our apprentices must study the theory of their work, and apply and develop the theory and practice in conjunction with each other to their utmost limits. We must help and encourage them in their efforts, bring out all the good that is latent in them, and show the world, as we did in the late war, that we are still a nation to be reckoned with.

MICA MINING IN BRAZIL.

As complete information had not been presented to the Institution of Mining and Metallurgy, on the subject of mica mining in Brazil, and the preparation of the mineral for the market, Mr. H. Kilburn Scott read a comprehensive paper on the subject at a meeting of the Institution, and at the outset called attention to the importance of the mineral on account of its use for insulating purposes in electrical machinery. The following paragraphs are, perhaps, among the most interesting:—

SOURCES OF SUPPLY.

The three principal mica-producing countries are: (*a*) British India; (*b*) Canada; and (*c*) the United States; speaking approximately, 50 per cent. of the total production comes from the first-named, and 25 per cent. from each of the two others. To these countries must now be added Brazil. Mica occurs in workable quantities in three of the Brazilian States, viz., Goyaz, Bahia, and Minas Geraes.

No exact information is available with regard to the deposits of mineral in Goyaz or Bahia, the quantity of mineral exported from the States having been very small, though it should be stated that the mica from the State of Goyaz is of excellent quality.

The principal mica deposits are pegmatite veins, lenses or dykes, which occur in the metamorphic schists near the City of Santa Luzia de Carangola on the borders of the States of Minas Geraes and Espirito Santo; it is from these deposits that practically all the mica exported from Brazil has been obtained. The country varies in height between 2,500 ft. to 4,000 ft. above the level of the sea, and the pegmatite veins run in an almost north and south direction along the side of the Cayama and Popogais mountain ranges which

form the watershed between the rivers Sao Joao do Rio Preto and Carangola.

As a rule, the rocks of Brazil are decomposed to a great depth, this is particularly the case with the metamorphic schists and in the regions where the pegmatite veins are seen. These veins seem to run parallel to each other, and some of them continue for considerable distances, for the author has noted a series of outcrops all in a line on several hills, one after another, apparently all belonging to one and the same vein. Owing to the country being thickly wooded, the outcrops of the pegmatite veins are not easily discovered, but the author has had his attention called to the presence of the pegmatite vein by projecting bosses of quartz.

The veins are from 20 in. to 10 ft. in width, and generally consist of kaolin, resulting from the decomposition of felspar, in which masses or "books" of mica are disseminated irregularly. The dimensions of the mica "books" vary considerably; "books" which are 10 in. by 20 in. by 6 in. may be met with, but the average size is much smaller than this, say 6 in. by 6 in. by 3 in., whilst the mica plates are often as small as those seen in an average mica schist. Further, only a small proportion of the "books" contain mineral of sufficiently good quality for export, and this is especially the case with mica got near the surface, where surface agencies have affected its quality. About half a dozen mines have supplied mineral for export, but only two of them have been worked regularly, viz., the Fonseca Mine and the Coronel Seraphino Mine.

About thirty tons of dressed mineral have been produced at Fonseca Mine; a large proportion of it has been used for chimneys for lamps, etc., in the country, and the rest has been sent to London and the United States. The total output of the Coronel Seraphino Mine is reckoned to amount to twenty tons.

Very little care is necessary in excavating the mica "books," owing to the decomposed state of the pegmatite; the ordinary unskilled native labourer, after a little practice, does the work quite satisfactorily.

USES OF MICA.

No other material has been discovered which can combine all the peculiar characteristics of the micas, and consequently they have a wide field of usefulness. The earliest use of mica was probably for windows and lanterns, but for these purposes it has given way to glass, except in very outlandish places and in the vicinity of the mines themselves. Owing to its capability of withstanding fairly high temperatures, it serves for making the little windows in stoves employed for heating. As soot impairs its transparency, it is not so suitable for stoves in which bituminous coal is the fuel, as for those in which anthracite or gas is used. However, exposure to the direct rays of a fire with a very high temperature, entirely destroys the laminar and elastic character of the mineral; the sheets become quite brittle, and are useless for any purpose to which ordinary mica is peculiarly adapted,

Mica chimneys for oil or gas lamps with round burners are becoming very general, especially in foreign countries. They are especially useful in places where glass would break from sudden changes of temperature due to mud and rain. In the city of Rio de Janeiro mica chimneys are in regular use both for the street lamps and for the oil lamps of the tramcars. The metal framework required for holding the sheets together, and so making the cylindrical chimney, cuts off a certain amount of light, and the effective luminosity of the flame is further reduced by the slight tinge of ruby colour in the mica.

The total loss of light from these two causes is reckoned at one candle power, so that a gas with a slightly higher illuminating power is required for a given useful effect if glass chimneys are replaced by those of mica.

Mica serves for making peep-holes in furnaces, as it enables the operator to watch the processes without suffering from the intense heat.*

By far the greater part of the mica brought on to the market is used for electrical purposes in the construction of dynamos, alternators, transformers and other apparatus. Owing to its elasticity, even thickness and high insulating properties, mica surpasses all the artificial materials prepared from either animal or vegetable substances. These artificial substitutes do not withstand heat readily; in fact, they carbonise, and so become conductors at temperatures above or about 150 deg. C. Some are naturally hydroscopic, and have also the disadvantage of being so much more bulky, they cause the machines to become larger and more unwieldly. Mica, on the other hand, is practically fireproof; it does not carbonise, and its insulative qualities are unaffected by time.

For electrical work it is specially necessary that the mica should be free from cracks, flaws, or specks, for these are a cause of imperfect insulation. The mica strips placed between commutator segments must be of soft quality, in order that they may wear down evenly with the copper. For this particular work soft homogeneous amber mica is chosen, and when split up into sheets $\frac{1}{32}$ in. thick, it will wear down at the same rate as the hard drawn copper segments. If the mica is too hard, the brushes wear the copper down quicker than the mica, and, on the other hand, if the mica is too soft, it powders away rapidly, and the commutator segments stand up above the pieces of mica between them. Both these conditions lead to sparking, which becomes worse and worse as time goes on unless the commutator surface is kept constantly trued up. For commutators from 7 in. to 9 in. in length the mica segments are in whole pieces; but for longer commutators whole strips would be so expensive, that it is usual to build them up of several thin layers arranged so as to break joint, and making the total thickness $\frac{1}{32}$ in.

* In India mica is largely used for ornamental purposes at festivals, marriages, etc., in pottery, curtains and cloths. Large numbers of pictures are painted on plates of mica, and the Hindus also use the material for medicinal purposes.

Notable British Papers of the Month.

Of late years a substance called "Micanite" has come into regular use for electrical work. It consists of thin plates of the mineral which are built up into sheets upon a longcloth or paper foundation by the aid of a cement with insulating properties, such as shellac. These sheets have the advantage of utilising the small, plentiful and comparatively cheap sizes of the mineral, and further, if a special cement is used, the thin plates of mica can be moulded into all sorts of shapes, such as are required in modern electrical appliances, viz., for lining armature core slots, for the end rings of commutator formers, for high tension transformer coils, for washers, etc. With natural mica these shapes could not be obtained, because the laminæ adhere to one another and will not slide over one another when they are bent.

The building-up process tends to give a product with better insulating properties than the natural mineral, because all faulty material is carefully avoided. When the artificial material is heated the cement softens and allows the laminæ to slide upon each other and so conform to any given shape under pressure; and on cooling it binds them together. Of course the cement must be impervious to moisture. According to information which the author has received from the Mica Insulator Company, micanite possesses insulating properties which are much higher than those of many other substances.

An important industry has grown up during the last few years in the United States in the manufacture of mica-flour, which is made by grinding up mica waste, which formerly was of no commercial value. According to a writer in a recent issue of the *Engineering Magazine*, the output of this material grew from 500 tons in 1890, to 7,000 tons in 1896. Mica-flour is used for wall-papers and other decorative purposes; mixed with oil it is employed as a lubricant, and it serves as an absorbent for nitro-glycerine in the manufacture of an explosive called "mica powder." Roughly ground mica is one of the components of a protective covering for steam pipes. A mixture of mica flour with sulphur and iron oxide is largely employed for making the globe strain and other insulators for overhead electric tramways, etc. For these insulators a steel or phosphor bronze shank has to be cemented into a sphere of insulating material, which will successfully withstand extreme variations of temperature without cracking or losing its insulating properties. This mixture referred to has been found to meet every requirement most successfully; in fact, it may be stated, without exaggeration, that but for the timely introduction of this form of insulator electric tramway traction would not be in the position it is to-day.

CONSUMING COUNTRIES.

The consumption of mica in the United States has increased enormously during the last few years. No figures are available, but the author would say that, approximately, they take one-half of the world's production, and Europe the other half. Much of the mica imported into England is exported to the United States, though in some cases the large American consumers are buying direct from Indian producers.

Indian mica has hitherto had the command of the mica market of the world, but as the Brazilian industry is developed this will no longer be the case. Undoubtedly, India enjoys many advantages, such as cheap labour, large and plentiful deposits; but, on the other hand, work can only be carried on for about nine months of the year owing to the bad climate, and in addition to this the mineral must be transported from thirty-five to seventy miles before it reaches a railway.

The facilities for mica mining in Brazil are very great. The low cost of mining of the mineral due to the decomposed character of the rocks, its good quality and the continuity of the deposit in the Santa Luzia district to the Leopoldina railway are points which will weigh in favour of the Brazilian mica industry when comparing its conditions with those of other countries. The sharp rise in the gold value of the national currency has caused a temporary halt in the development of Brazilian mining industries, but it may be taken that when prices of labour and material are adjusted, as they must be to the new conditions, mining will be just as actively engaged in as heretofore.

THE EDUCATION OF ENGINEERS IN AMERICA, GERMANY, AND SWITZERLAND

PROFESSOR W. E. DALBY'S paper on the above subject, read before the Institution of Mechanical Engineers, should be specially interesting to readers of PAGE'S MAGAZINE, in view of the free ventilation of the subject in our columns a few months ago. In the course of his paper the author pointed out that—

Long before their competitors had any engineering industries at all, the British were fortunate in the possession of flourishing manufacturing centres which practically gave them the monopoly of the world's trade, a monopoly partly due to their fortunate possession of coal and iron, but chiefly due to the genius, inventiveness, perseverance, shrewdness, and business acumen of the great British engineers of the last century, many of whom might be found on the roll of Past-Presidents of the Institution of Mechanical Engineers. As the industries developed, the method of training apprentices gradually took form and became a system, and probably most of those present had served an apprenticeship under some form of the system, namely, a seven or five years' apprenticeship in the works.

With scientific progress, changing methods of manufacture, and the advent of electricity as a necessary part of the engineering equipment of every mechanical engineer, there had been scarcely any change in the recognised method of training engineers. Sir Joseph

Whitworth. President of the Institution in 1856-7, perceived that the engineers of the future must be trained in scientific principles as well as in workshop practice and even so long ago as 1868 tried to find a remedy by the foundation of his scholarships. scholarships which had done a vast amount of good, but he ventured to think not entirely in the direction Sir Joseph Whitworth contemplated. In recent years courses of instruction in the scientific principles of engineering had multiplied at the Universities, and at institutions of kindred types and equal standing from a purely engineering point of view. At the present time, therefore, there was no difficulty in obtaining a scientific training of a high character. The author thought it would also be conceded that a youth could get a training in workshop practice in the first-class factories of this country second to none in the world.

THE WEAK POINT OF THE ENGLISH SYSTEM.

The weak point in the English system was, however, the want of co-ordination between the workshops and the colleges. Many employers looked askance at a college-bred youth, and there was no doubt that many college youths quite deserved it. But not more so than many who were trained entirely in the works. It was too often forgotten that a college could not give a youth ability. All that could be done was to train what abilities he happened to bring to the college with him.

Presuming that the members all agreed that the training of an engineer should be partly in scientific principle and partly in workshop practice, it was, he thought, a fit subject for discussion in the Institution as to what course of training was best adapted for carrying this principle into effect, so that future engineers of this country should not be at a disadvantage in any one respect in comparison with the engineers of other countries.

As a basis of discussion, the author cited a number of facts in connection with the training of engineers in America, Germany and Switzerland. He incidentally remarked that—

There is an essential difference in the method of training in America and Germany. In America the course of instruction is very exactly laid down, and the student is compelled to follow it step by step. Slight variations are permitted in the form of options, to use their term, in the later periods of the course. But, whatever option is taken, the student must go through with it. He gets his degree from the gradually accumulating results of terminal and sessional examinations, ending finally with a thesis. He is, in [illegible] put through a thoroughly well-organised species of educational drill and must work or fail out.

In Germany the students of their great technical high schools enjoy the "Academische Freiheit" [illegible] University system of that country. No student is compelled to take any special course. For his convenience definite courses are arranged and laid down in the school calendar, but the sequence of lectures therein stated are not binding. There is in no sense a prescribed course. The courses are only recommendations, and students may follow them or not as they please. Degrees are granted by examination, chiefly oral in character, by the professors of the schools.

In order to give an idea of the weight attached to the different subjects of study, the author estimated the percentage of the whole courses devoted to different subjects, grouping them in the way familiar to members. The figures are only approximate, but are sufficiently accurate to bring out the peculiarities of the several courses.

TABLE SHOWING THE PERCENTAGE NUMBER OF HOURS' INSTRUCTION GIVEN IN THE MECHANICAL ENGINEERING COURSES UNDER CONSIDERATION.

	Massachusetts Institute	Cornell.	Berlin Technical High School	Zurich Polytechnic
Mathematics	8	5	14·5	19·2
Physics	5	8	6·8	6·0
Chemistry	7	7	4·1	3·0
Applied Mechanics	7	10	22·5	19·5
Mechanism	4		8·0	—
Steam Engine, including Thermodynamics	6	6	4·1	8·0
Mechanical Drawing	20	20	31·0	30·3
Electrical Engineering	2	2	3·4	5·0
Commercial Subjects	2	—	8·0	
Workshops	14	30	Nil	Nil
French	6		..	..
German	3	3	..	..
English	8	—	.	.
Engineering Laboratories	5	9	4	?
	100	100	100·0	100·0
Attendance Hours	3,000	3,000	4,000	4,000
Distributed Over	Four Years.	Four Years.	Three Years.	Three Years.

[1] Includes Mechanism

[2] Includes Freehand, Machine Drawing, and the lectures connected with Machine Design.

[3] Laboratory courses are taken in addition, but it is difficult to estimate how much is recommended

The table shows that an American course may be taken as 3,000 hours' instruction distributed over four years. The Continental courses in the comparison are 4,000 hours distributed over three years, and this independently of laboratory work. The fourth year is

not included, because it is so cut up with examination work. It must not be forgotten, however, that an American student actually receives 3,000 hours' instruction; a German or Swiss student is only recommended to attend courses aggregating 4,000 hours. Actually, he may work just as many hours as he chooses.

The figures in the table indicate a second essential difference between the American and Continental courses. In America a large proportion of the time is devoted to workshop practice. In Germany and Switzerland no time at all is given to this. In both Charlottenburg and Zurich there are fine engine laboratories, but no testing laboratories belonging directly to the schools. What testing of materials is done takes place in the Government testing department, which happens to be adjacent to the school in each case. In America a testing laboratory is a feature of the course.

ESSENTIAL DIFFERENCES.

In brief, the American courses are more practical in character, they include more laboratory training than is recommended in the German course, and devote a large proportion of the course to the teaching of handicraft skill.

In Charlottenburg and Zurich no attempt is made to teach handicraft skill, and the bulk of the training is given in the drawing office, though in addition, a considerable amount of time may be given to engine testing.

In both Charlottenburg and Zurich a student finds himself at the end of his course with a degree or diploma, age 23, and no workshop training except a year, which is insisted upon as a preliminary to entry for some students at Charlottenburg.

AMERICAN PRACTICE.

In America a student finds himself with a degree or diploma, age 21, with what handicraft skill and workshop practice he has picked up in his college workshops. With these assets he has no difficulty in getting further practical training in the large works of the country. Employers take him, without premium, and pay a wage sufficient for maintenance straight away, recognising that his knowledge places him in a different position to ordinary apprentices. In this way they get highly trained men into their works, and by their own observation soon discover whether the youth possesses, in addition to intellectual acuteness, the qualities which go to make a successful business man or a good organiser, and recruit their staff accordingly.

CAN BRITISH METHODS BE IMPROVED?

After considering these facts, the question arises, is the British method of training engineers better or worse? Can they improve their methods in the light of what is being done abroad? Most people would consider the method at Charlottenburg and Zurich too academical. A youth must surely be handicapped afterwards, in whatever position he finds himself, if he is not familiar with the machine tools and appliances used in engineering works from actual experience as a workman.

Many also, whilst admiring the American system of workshop instruction, think that it is better that this instruction should be obtained in a workshop under the actual conditions of practical work, for the reason that a youth who is to become a leader in the future requires to know as much about the men, their habits of thought and their point of view as possible.

One thing is certain, however the American German and Swiss student starts his course with a far better education on which to build, than is the case with us. Much time is wasted at colleges here on teaching things which should have been taught at school.

The great defect in the present system here, as the author has already stated, of training engineers is the want of co-ordination between the colleges and the employers. If the employers will concern themselves with the question, he feels sure their attitude will speedily change.

The general opinion seemed to be that a course arranged so that the winter months are spent at college, and the summer months in the works is a desirable one, and one from which good results may be expected. Such an arrangement obviously cannot be worked without the co-operation of the employers. The alternating system must not be regarded as experimental. Our Admiralty have had something very similar in operation for forty years and the system has produced a famous roll of chief constructors. The Scotch Universities lend themselves to the system, and he believes Glasgow students in engineering consistently study in the winter and work in the summer. Mr. Yarrow has included this alternating system in the apprenticeship rules he has just made for his works. These rules were read during a recent discussion at the Institution of Naval Architects, and the names of several firms who have acted on similar apprentices under similar conditions were also given.

Leaving this point for further discussion, the author would merely remark that no system will be of any avail without the whole-hearted co-operation of the employers and manufacturers; with their co-operation almost any system may be made to work.

COMPARATIVE STATEMENT OF APPRECIATION.

The paper concluded with a few figures indicating the comparative appreciation in which professional education is held.

The figures concerning Germany and Great Britain are taken from a schedule published by the Association of Technical Institutions.* Those referring to the United States are quoted from the Report of the Commissioner of Education.

* *See* also a pamphlet issued by The Association of Technical Institutions, which can be obtained from Professor Wertheimer, Merchant Venturers' College, Bristol.

NUMBER OF STUDENTS DURING THE SESSION 1901-2 IN THE SUBJECTS STATED.

	German Technical High Schools.	United States Institutions for Higher Education	Great Britain. University and Technical Schools and Colleges.
Agriculture	42	2,852	411
Architecture	1,440	459	—
Civil Engineering ...	2,257	3,149	[1] 2,250
Mechanical Engineering	[1] 3,503	4,450	
Electrical Engineering ...		2,555	
Chemistry and Metallurgy	1,186	[2]	667
Naval Architecture ...	318	4	33
	10,740	13,405	3,370

[1] These figures do not include the students at Brunswick or Stuttgart.

[2] Chemistry not given separately, but probably included in "General Science Courses," the number attending being 10,925.

[3] Included in Mechanical Engineering.

The 10,740 students attending the German Technical High Schools would be over eighteen years of age.

The students attending the United States institutions are all probably over sixteen. The 3,370 students for Great Britain are only obtained by including in them all students over fifteen taking a day course of over twenty hour from per week at the technical schools and polytechnics. Probably there are not more than 500 students over seventeen years of age in the whole of this country taking courses in the above subjects, which can clearly be compared with the 10,740 in Germany, or the 13,000 in the States. These figures indicate that the bulk of engineer apprentices in the United Kingdom receive no scientific learning at all.

AUTOMATIC COUPLING.

WHAT Mr. Charles Rous-Marten, in another part of the Magazine, calls "the eternal automatic coupling question" was recently under consideration at a meeting of the Society of Arts, when an important paper was read by Mr. T. A. Brockelbank, who was stated by one of the speakers to have given the greater part of his life to the solution of this problem.

Mr. Brockelbank first argued that humanity demanded the adoption of automatic coupling in this country, and drew an appalling picture of the loss of life on English railways under present conditions.

[illegible] men engaged in the work in the United States [illegible] were killed or injured at [illegible] engaged in the country named last 27,000 with 1 in 45, and we see at once that in 1902 the record is against this country.

How many people realise that according to the railway companies' own returns to the Board of Trade, 150,000 railway employees are killed or injured in this land in ten years.

The author estimated the saving of time which would accrue from a general adoption of automatic couplings in this country as follows :—

In the United Kingdom to-day there are somewhere about 15,000 stations, junctions, sidings, quarries, and collieries. If in each 24 hours we can save one minute (on the average) by automatic couplings in these 15,000 stations, etc., then in twelve months a saving representing over ten years might and day would result, equal to one hundred years inside any ten years working on English railways.

COST OF APPLICATION.

Dealing with the cost of a general alteration in the coupling system, he remarked :—

There is a very serious point for railway shareholders in this delay in adoption of automatic couplers in the United Kingdom as the figures of the wagon stock of railways I now submit clearly indicate. Putting the cost of alteration at £5 per wagon, in 1880 all the goods wagons could have been so equipped for £1,861,770, by 1890 (ten years later) it had reached £2,590,071, by 1900 (another ten years) it rose to £3,506,810, and to-day it must reach £4,000,000, or about half a million more since the Act of 1900 was passed.

I commend this point to the careful consideration of all concerned, for automatic couplings have to come sooner or later.

TYPES OF COUPLINGS.

Discussing the mechanical aspects of the problem, Mr. Brockelbank claimed that during the progress of conversion the immense and complex traffic of the United Kingdom would not suffer. Various types of couplings were described. He described the Brockelbank coupler fitting as very simple :—

A bent lever with a cranked handle at each end supported by four brackets, is bolted underneath the wagons. Directly under the drawhook plate of the wagon is bolted a very simple bracket, also of bent steel, 5ths of an inch thick, bent to a desired shape on the [illegible] a tippler, again made of the [illegible] in two plates bent, but each plate bent shaped differently before bolting together; this tippler, when actuated by the lever, which passes behind it, lifts and releases the coupler or drops it into connection.

It will be perceived at once by any railway man that by this simple process we get clear of all necessity to consider what sort of under-frame or longitudinal

timbers there are on a wagon. It does not matter with this coupler, which is entirely unattached to the fittings, where the brake handles are, as these coupler handles need never go near them, whilst the fastening bolts in wagons may practically monopolise the buffer beam, but need not disturb us, for if it should be found that any railways or railway wagon builders have devised some further complications, we can grapple with them.

This is all that is required for coupling or uncoupling the wagon, or setting for automatic action by hand lever, the stroke length of which is only about 16 inches, and is worked shoulder high by the shunter who is free to look after his own safety unhindered. The couplers take the place of the three link cham, being slung in the same slot in drawbook from which they hang to-day.

ATTITUDE OF THE RAILWAY COMPANIES.

The author alluded somewhat bitterly to the attitude of the various railway companies.

Of the obdurate character of railways as a body, one can hardly speak too strongly, it is largely the outcome of the immense Parliamentary influence they hold, and the fact that each of the hundred companies is a kingdom in itself jealous of each other. The regal chairman, the suave general manager, the important director, and the dictatorial engineer, are all convinced that their own management and rule are unequalled, they are most admirable cold water powers, with which to extinguish the burning zeal of inventors, but when the result of this situation extinguishes 20 millions of dividends to shareholders, and sacrifices, as it has done in the past, railway passengers' lives and limbs, and railway servants' lives and limbs, it is surely time something drastic was done.

One large wagon owner not so long since told me concerning another important alteration on railways other than couplers demanded by the Royal Commission, that he confidently expected that railways will be able to hold off compulsory adoption for twenty-five years. Three years of that period are already gone, and as matters are tending it cannot be completed within fifteen years.

From one undertaking which own 1000 wagons and of whose seven directors three are railway directors, I hold the following written declaration of unending resistance to automatic coupling. "It is perfectly certain that automatic couplers will never come into use generally in this country unless it is through legislative action." "We shall certainly not use any description of automatic coupling unless forced to do so."

A further reference is still more pronounced.

Looking back over thirty years, I do not find it easy to forget the heartless instances of unconcern as to railway servants' dangers which confronted me almost at every turn, whilst I gladly acknowledge a few noteworthy exceptions.

Says the author in conclusion :—

With the diversity of interests and opposing characters of the railways of the United Kingdom, it is hopeless to expect a settlement by them, and anything short of public testing and final selection by the Board of Trade, and compulsory enforced adoption of that selection is hopeless in this country.

This question is now one for the House of Commons and the nation; nothing less can settle it decisively, in the face of railway opposition and Board of Trade apathy.

COMING EVENTS: JUNE—JULY, 1903.

June.

6th. Birmingham Association of Mechanical Engineers: Half-yearly Meeting and Social.

8th.—Society of Engineers: Ordinary Meeting at 7.30 p.m.

9th.—The Institution of Gas Engineers: Annual General Meeting, at the Institute of Mechanical Engineers, Storey's Gate, Westminster. Mr. Andrew Dougall, Junr., to preside.

10th.—The Institution of Gas Engineers: Annual General Meeting (*continued*).

11th.—The Institution of Electrical Engineers: Concert at the Royal Albert Hall.—The Institution of Gas Engineers: Annual General Meeting—(*continued*).

13th.—Birmingham Association of Mechanical Engineers: Annual Picnic. North of England Institution of Mining and Mechanical Engineers: Council Meeting at 1.30 p.m.; General Meeting at 2 p.m. The Mining Institution of Scotland: General Meeting at Kilmarnock.

13th.—Building Trades Exhibition opens at the Royal Agricultural Hall, Islington.

16th.—The Institution of Civil Engineers: Eleventh "James Forrest" Lecture at the Institute, 7.30 p.m.

17th. The Institution of Civil Engineers: Engineers-Conference at the Institute of Mechanical Engineers. Opening of Conversazione.

18th.—The Institution of Civil Engineers: Engineers Conference—(*continued*).

19th. The Institution of Civil Engineers: Engineers' Conference (*continued*).

23rd.—The Institution of Electrical Engineers: Annual Conversazione at the Natural History Museum.

24th.—Society of Arts: Annual General Meeting.

29th.—Proposed Sir Henry Bessemer Memorial: Committee Meeting.

30th.—Society of Arts: Conversazioné.

July.

1st to 8th.—Colliery Appliances Exhibition, Agricultural Hall, Islington.

NEW CATALOGUES.

Samuel Denison and Son, Hunslet Foundry, Leeds.—An illustrated pamphlet of eight pages and cover describing the Blake-Denison Continuous Weigher (patent). This is an automatic weighing and recording machine, which, we are told, can be used on any kind of conveyor, whether textile band plate, box, bucket, or other pattern, and has been approved by the Board of Trade. The chief features of the machine are: (1) A steelyard balanced to suit the unloaded conveyor, and arranged to rise accurately in proportion to the load. (2) A gripping device to hold the steelyard fast at suitable intervals. (3) A measuring gauge, or quadrant, to ascertain the weight indicated by the steelyard when so held. (4) A recording mechanism to exhibit the result. It is stated that the travelling speed of the conveyor may be anything from 30 ft. to 350 ft. per minute.

Fleming, Birkby, and Goodall, Ltd., West Grove Mill, Halifax.—A very useful daily memory "jogger" for desk use, in the form of a perforated pad with separate sheet for each day in the year, ruled for memoranda, appointments, etc. At the foot of each sheet appears a short advertisement of the firm's principal speciality—the "Troon" belting. A somewhat unique, as well as useful, form of advertisement.

Ernest Scott and Mountain, Ltd., Close Works, Newcastle-on-Tyne.—A series of well-printed pamphlets describing and illustrating some recent pumping, hauling, and power plants that have been erected by the firm, in connection with collieries and works. Circular 25 describes a large pumping plant recently completed for a large mining engine builders, of Sheffield. Circular 26 describes an electrical winding gear. Circular 28—An electrical power plant for the Normanby Iron Works. Circular 40—Electrical ventilating plant for the Micklefry Coal Company. Circular 43—Electrical pumping plant, hauling and lighting, for the Tredegar Coal and Iron Company. Circular 47 describes an electrical haulage plant supplied to the Consett Iron Company. Accompanying the pamphlets are some excellent reproductions in plate form, from photos of work carried out by this firm, including a 300 kilo-watt set, power house, bi-polar type dynamos, a pit breaking machine with motor attached, a 10-ton travelling crane, a 5-ton three-motor pig bed crane converted for electric driving, patching machine with electric motor, an electrical drive punch and shears, small electric pumping set, generators, motors, steam dynamos, winding and haulage gear, etc., etc.

Electromotors, Ltd.—An illustrated price list of excellent design and production. While giving the prices of many different type of electric motors, these specialities are illustrated by means of some [illegible] which, on a white ground, and surrounded by a peculiar green tint colouring of frame design appear to great advantage. The firm manufactures three types of machines: semi-enclosed, enclosed-ventilated and enclosed. They are of the four-[illegible] pattern with reversed drum wound [illegible] natures, specially designed to stand rough usage, [illegible] with cooling. A useful telegraphic code, and table giving particulars of weights of standard motors and baseplate appear at the end of the book.

Fraser and Chalmers, Ltd., 43, Threadneedle Street, London, E.C.—The above firm have secured rights from Messrs. Keating Bros., of Hanover, Germany, to manufacture their patented two-cycle gas-engine, and we are favoured with a catalogue which fully describes its working. Other specialities manufactured by the firm are as follow: Riedler blowing engines, Riedler Stumpf blowing engines, Riedler air compressors, Riedler electric pumps, Riedler air and steam pumps, Rand compressors, Cornish pumps, Rand rock drills, Robins' belt conveyors, boiler feed pumps, winding engines, Corliss engines, boilers, condensing plants, roasting machinery, smelting and refining machinery, complete stamp mills, crushers and pulverizers, concentration machinery, Pelton water wheels, prospecting outfits, cyanide plants, and the Elmore oil concentration process. A reprint from the *Colliery Guardian*, which accompanies this catalogue, is interesting as describing a double King-Riedler air compressor built by this firm for the Powell Duffryn Steam Coal Company.

The Anglo-American Machine Tool Company, 5, Lawrence Pountney Hill, London, E.C.—An illustrated index and price list of the general catalogue of machine tools, embodying illustrations and condensed descriptions of the following specialities: New patent tool open side planing machines, vertical turning and boring machines, patent plain and universal milling machines, Anglo-American lathes, horizontal boring and radial drilling machines, tool-room grinding machine for cutters, reamers, taps, etc., workshop appliances and tools, steel pulleys and line shaft fittings. A useful telegraphic code appears at the end of the catalogue.

Messrs. John M. Henderson and Co., King Street Engineering Works, Aberdeen.—We have received from this firm an interesting card, suitable for hanging in the office, showing their cableways at work. The illustration, which is mounted on stout card board, shows a cableway built of mass concrete, with an overhead, by means of a cableway of 1,000 feet span, bearing a maximum load of three tons. A crane is also called to the Henderson cranes, Scotch derricks, hoisting machinery, quarriers' and contractors' plant, etc.

The Wilson Filter Syndicate, Ltd., of Glasgow (represented in London solely by Mr. George H. Hughes, A.M.I.Mech.E., 97, Queen Victoria Street, E.C.) have recently issued a booklet full of information regarding their filters and filter presses. One of the chief characteristics of these filters is the ease and rapidity with which they can be emptied and the cloth brushed thoroughly clean, thus enabling them (so we are informed) to perform three or four times the work of an ordinary press within the same time. It is also stated that one attendant can control a number of these filters or filter presses, and the time occupied in emptying and cleansing need not occupy more than five minutes each.

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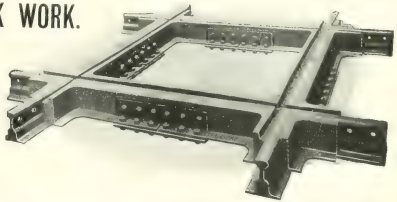
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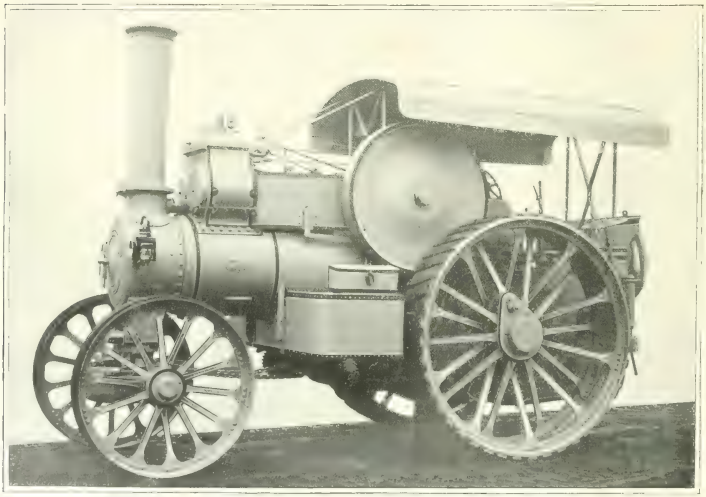
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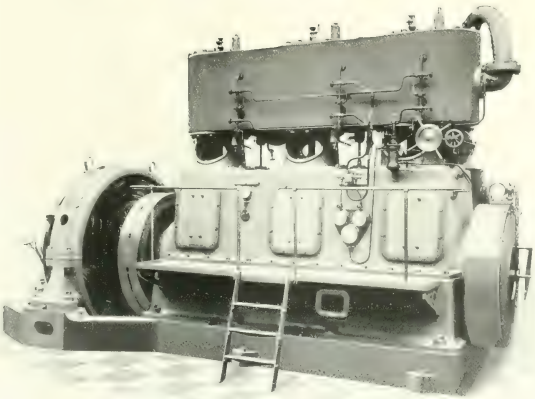
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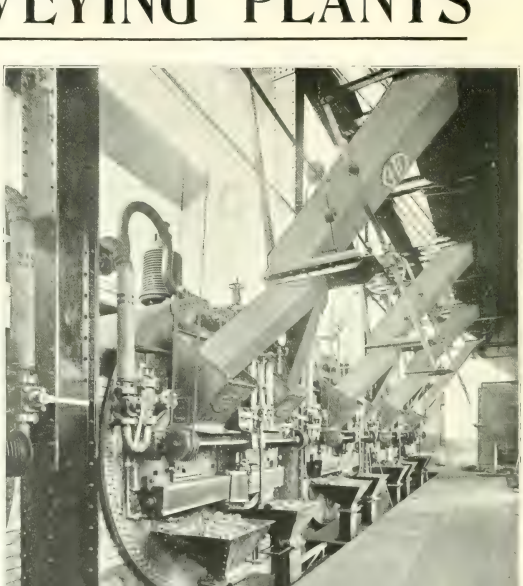
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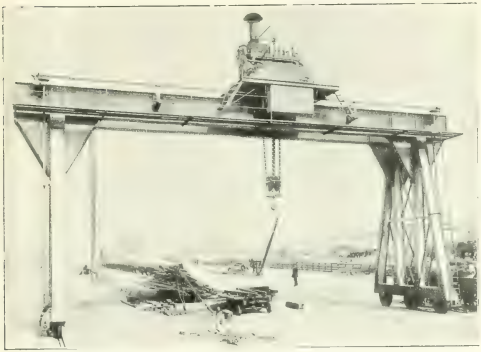


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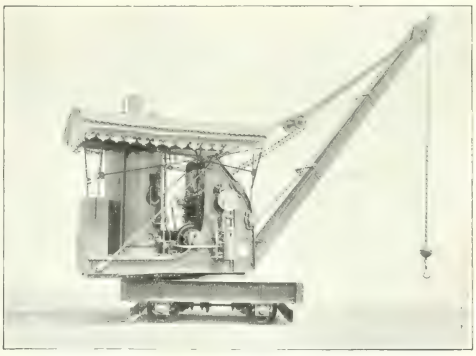
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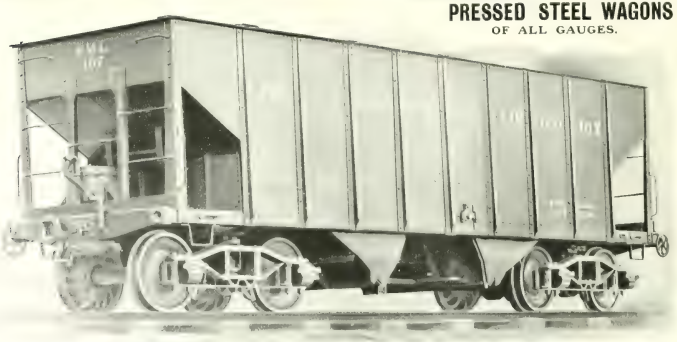
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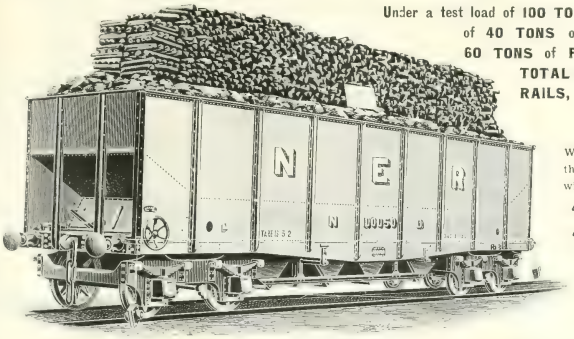
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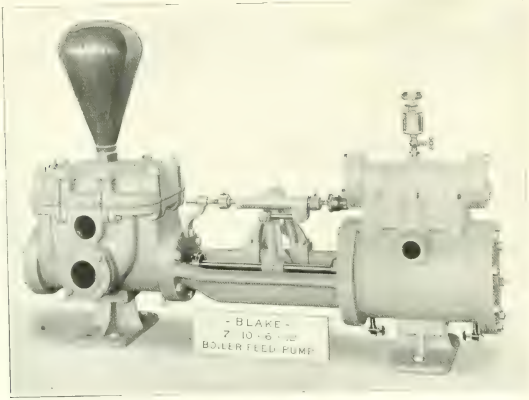
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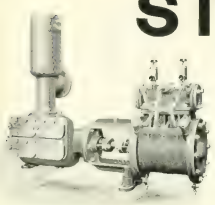
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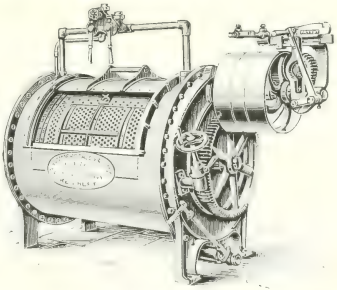
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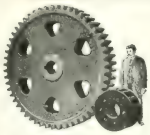
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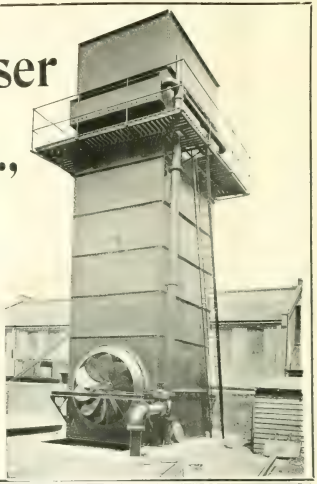
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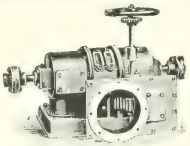


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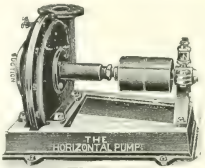
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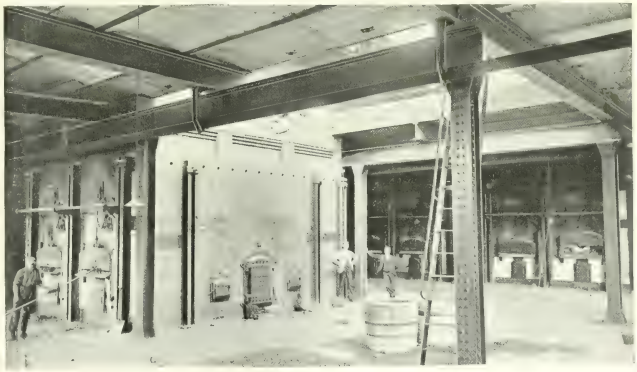
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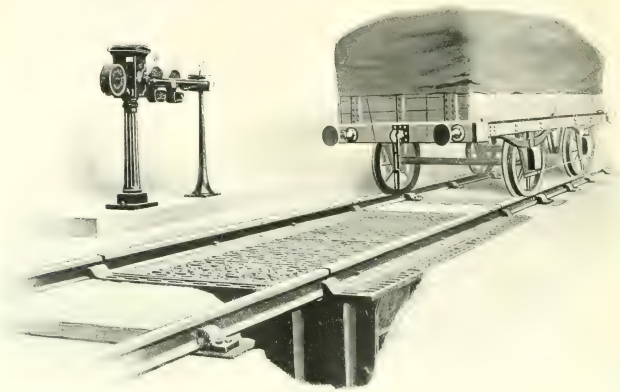
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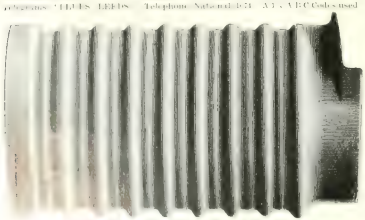
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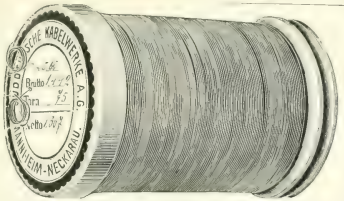


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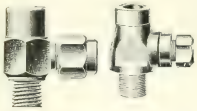
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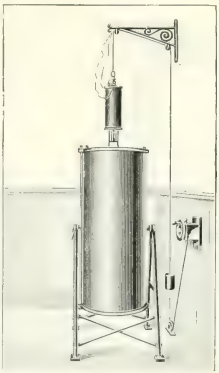
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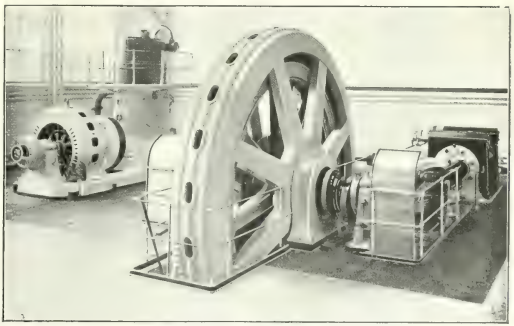
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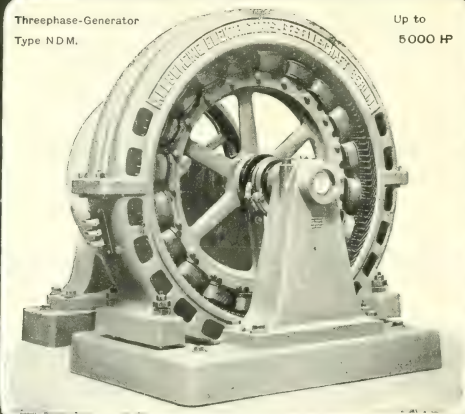
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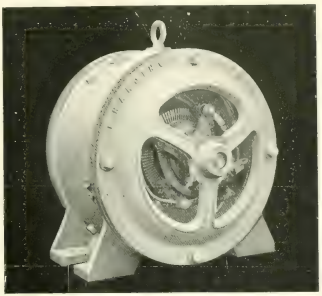
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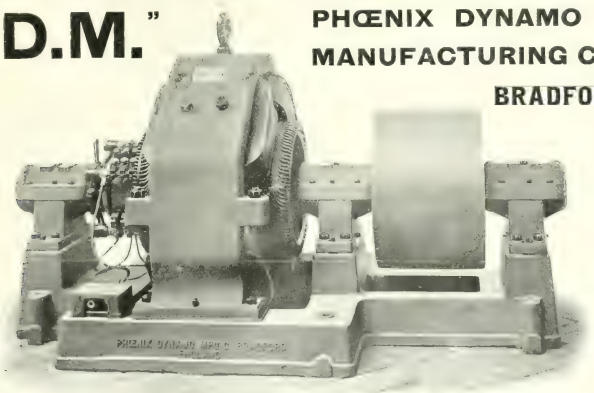
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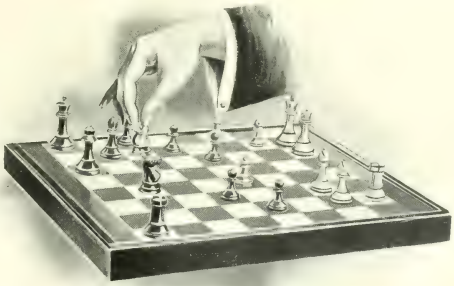
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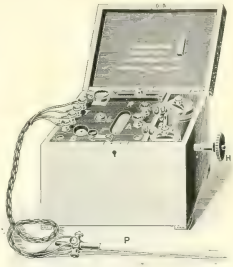
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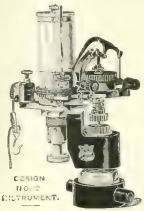
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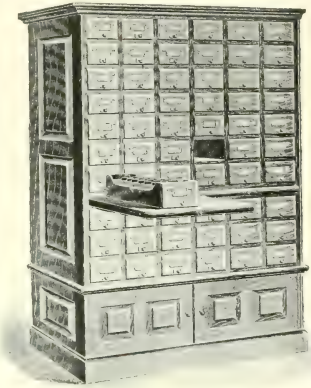
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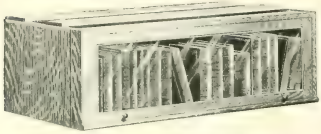
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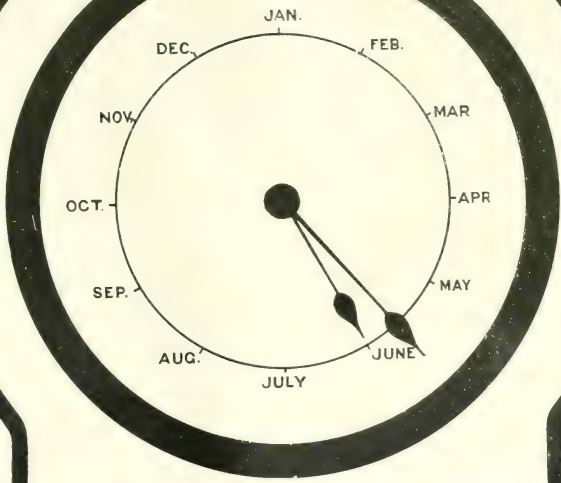
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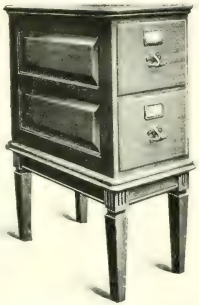
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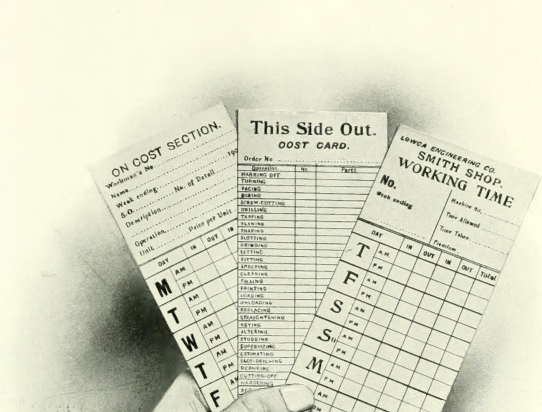
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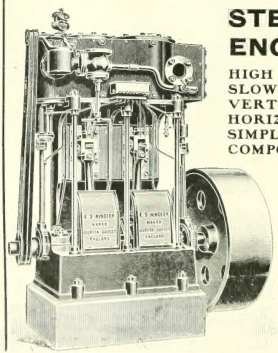
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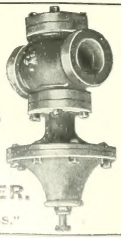
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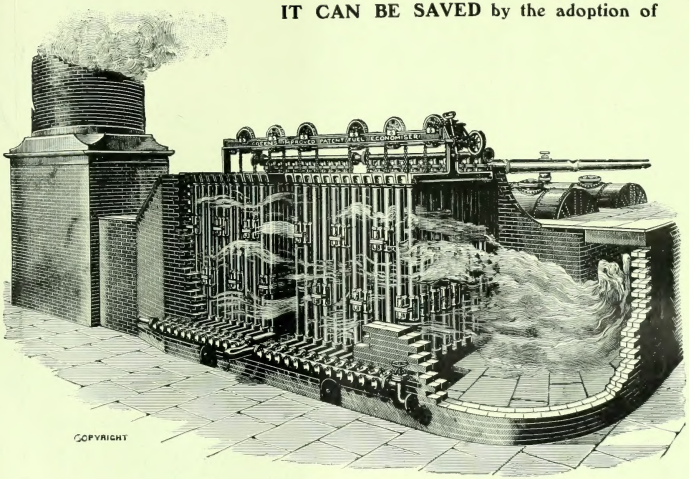


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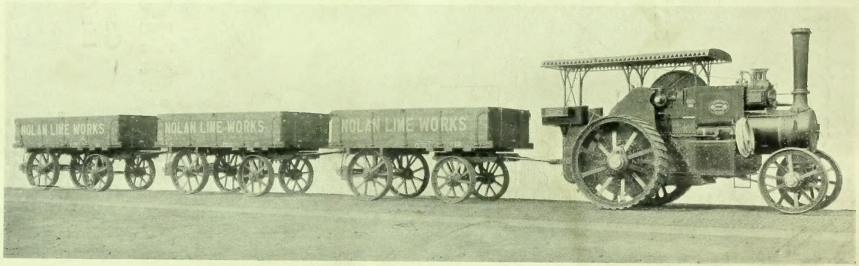
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